DOCTOR OF PHILOSOPHY

Double Vision

A practice-based investigation of art and differential perception

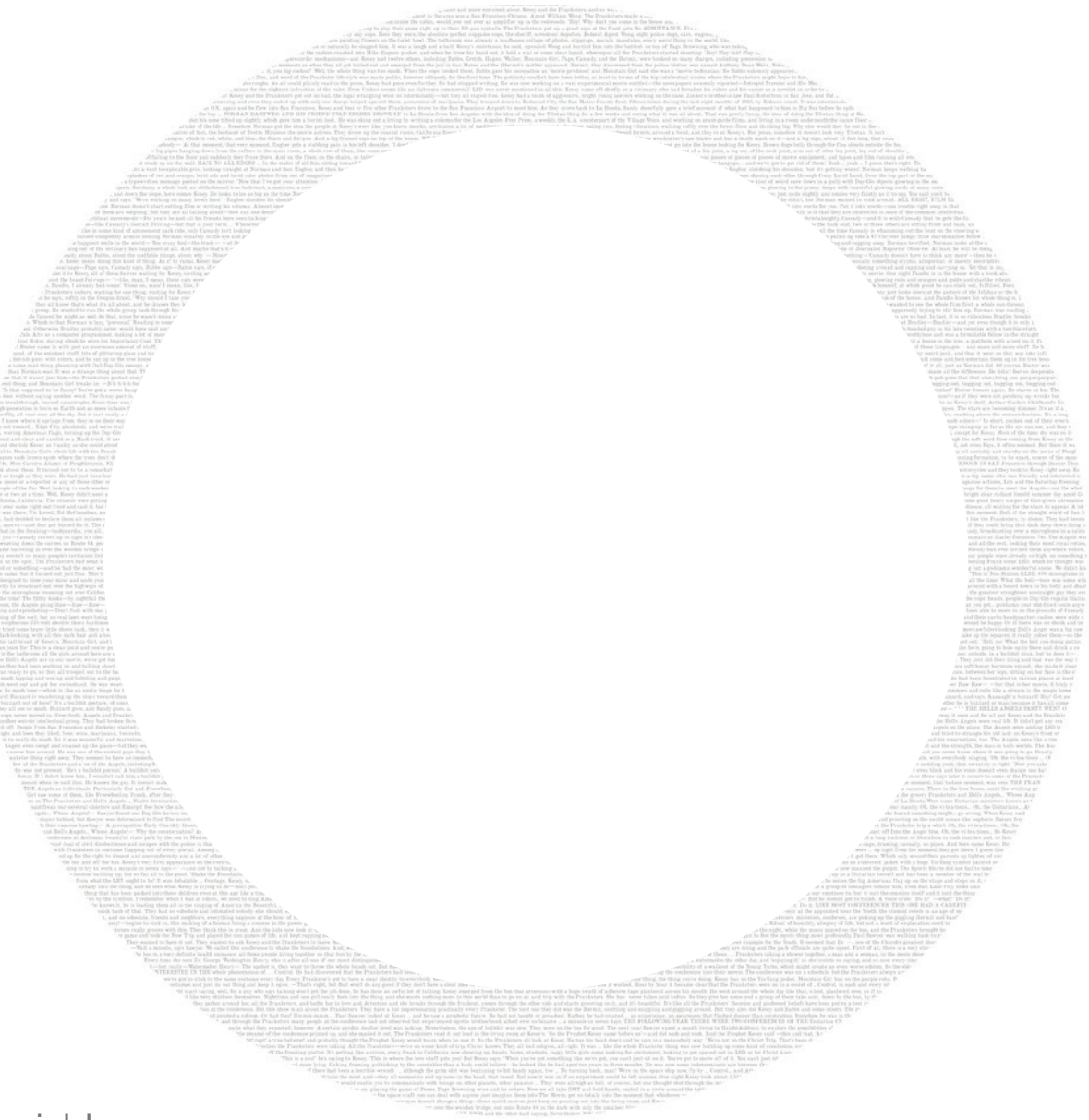
Lyons, David

Award date:
2017

Double Vision

A practice-led investigation of art and differential perception

A thesis submitted to the University of Dundee for the degree of
Doctor of Philosophy in the School of Art and Design



David Lyons
Duncan of Jordanstone College of Art and Design
June 2017

TABLE OF CONTENTS

DECLARATION

I, David Lyons, am the sole author of this thesis. Unless otherwise stated all references cited have been consulted by me. The work in the thesis is an accurate record of work done by me and has not been previously accepted for a higher degree.

David Lyons

ACKNOWLEDGMENTS

The scope and time required of this practice-led PhD was made possible only with the support of others. This research happened over an extended period of time, and at long stretches under very focused concentration. That focus, I fear, resulted in a lack of acknowledgment, or even realization, of support that was given. For that I apologize. To those that me gave time, ideas and encouragement I am most grateful.

This work would not have been possible without Abigail Lyons, my partner in life. Without her patience, support and editing, this document would not exist. My daughter, Chloe, and son, Owen, endured my absence many nights and weekends with acceptance and grace. I would like to dedicate this work to them, my family.

My mother, Diane, instilled in me a love of knowledge, my father Patrick, the benefits of hard work. Thank you both.

I found encouragement, inspiration and friendship in my supervisor, Dr Paul Harrison. His influences will be long lasting. Thank you, Paul. Professor Murdo Macdonald was a Zen master of supervision allowing me to discover the path I needed to follow. Thank you, Murdo.

I am in debt to my collaborators, Dr David Flatla, computer scientist at the University of Dundee, and Manchester based sonic artist, Raz Ullah. The research would not have been the same, nor as successful, without their participation. I am looking forward to our future endeavours.

Univerity of Amsterdam philosopher Dr Martin Lipman's contribution was very welcome as was his conversation.

Thank you, Anne, and the others from the Crafts Group at the Dundee Blind and Partially Sighted Society, for letting me participate in your activities over those many weeks.

I would like to thank the many people involved in the testing, production and exhibition of the art. I owe Mark Hunter, Scott Hudson and Adam Lockhart particular thanks. Clare Brennan, curator extraordinaire, did an outstanding job in multiple exhibitions of the work.

Dean Meeker, my MFA mentor, once told me he was surprised at how many artists thought that they had invented themselves. I am pretty sure I was invented by Dean, and my undergraduate supervisors Ralph Arnold and Justine Mantor. Thank you and thanks to all the other educators, academics and artists who helped form who I am.

I would like to offer my appreciation to my examination panel: the examiners, Professors David Ferry and Calum Colvin, and the convenor, Arthur Watson.

Financial support, for which I am grateful, was provided by the School of Arts, Media and Games at Abertay University.

ABSTRACT

Double Vision: A practice- led investigation of art and differential perception is a series of five interrelated practice-led research studies into artistic expression controlling perceptual experiences between audiences of varying visual acuities. Significant refinements occurred between the first and second, and second and third studies. The last four studies were conducted with the aim of understanding vision's influence on perception.

Double Vision's lead methodological approach was artistic practice. Other methods were employed according to the needs of that practice. They included iteration, collaboration, exhibition and testing.

The research questions of *Double Vision* were refined in response to the results of artistic practice. That evolution resulted in two interrelated questions: *Can artwork be intentionally created to be experienced differently dependent on one's visual abilities?* and *If so, can those experiences be shared?* A further question, *'Can an analogy to colour deficient vision be created that engages both those with colour vision deficiency and the typically sighted?',* concludes the investigations.

Artwork was realized through printmaking, animation and multimedia formats. Its context and content derived from many forms, notably the Ishihara *Test for Colour Deficiency*, writings of William Blake, contemporary music and philosophy.

Augmented reality was employed to facilitate the translation of visual perceptions between targeted audiences. A number of exhibitions were held exploring these themes.

PREFACE

Theodor W. Adorno begins his *Aesthetic Theory* by proclaiming the autonomy of art shows signs of 'blindness' due to its forfeiture of spontaneity for social function. And further, that 'art's inescapable affirmative essence has become insufferable.' (Adorno 1997, p.3)

The title for the second research study of *Double Vision*, *Double Blind Test Series*, not only comments on my target audiences' visual acuities and the oft applied pseudo-scientific construct to academic art research, it is also my way of stating agreement with Adorno. I was 'double blind' because initially I had forfeited spontaneity for function in seeking affirmation.

The photorealist painter Chuck Close famously said: "Inspiration is for amateurs — the rest of us just show up and get to work." For the constructs of art in academia this is problematic. Academic research, as opposed to artistic practice, typically needs a question to answer. That is a bit different than a question that needs answered, and also different than artistic practice, which comprises actions of creation.

Originally I approached this problem as a designer. Having worked as both an artist and a designer, I knew that I designed in response to clients' needs. They had problems that needed to be solved. But as a designer without a client, I had to invent that problem.

I had solved a problem for myself a few years previously - a need to communicate quickly and effectively to my students online was solved through the use of video. In the need to create a new problem to justify my Ph.D. research, I transposed aspects of that online communications issue onto a potential new client group. Thus, I created a problem which had neither existed before nor had ever been articulated. That original proposition was *Graphic Design For The Blind*, intended as systematic investigation and codification of a sensually expressive, tactile, non-visual typography. Or, more simply, the creation of a more expressive form of Braille. With hindsight it is obvious that such a proposition would be problematic. Without client need there is no need for the research and no need for a solution. If it ain't broke, don't fix it.

Once the limitations of my initial plan became evident, I was able to shift my motivational process from that of a designer to that of an artist while retaining some of the practices required of design.

When working as an artist, I am content with making stuff. For me it is intrinsically motivated. I seek out new challenges, observe, create and iterate for both the

enjoyment and the knowledge gained from it. My work is not driven by external pressures or reward (Ryan, R. and Deci, E. 2000: Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist.* 55).

My thesis became one led by practice, and that practice drove the questions that needed to be answered.

Keeping the design driven iterative process and clearly targeted audiences which worked well for me initially, I identified and examined my creative motivations through practice (sometimes at its most basic), reflection and self-evaluation. This approach became embedded, becoming my research method with its end-point undefined. By switching from my extrinsic motivations as a designer to those intrinsic ones of an artist, I was able to use that original artificial starting point to chart a path on which I learned a body of knowledge and applied it in new and novel ways through creating a body of work.

It is my hope to have both generated a body of work that is innovative and enlightening, and chronicled its formation in this document in a way worthy of the reader's time.

INTRODUCTION

1.1 OVERVIEW

Double Vision is a series of five interrelated practice led research studies into artistic expression controlling perceptual experiences between audiences of varying visual acuities. Focus shifted between the first and second studies, and a significant refinement occurred between the second and third studies. The last four studies are conducted with the aim of understanding vision's influence on perception. This is done in the context of red-green colour vision deficiency (CVD), commonly known as red-green colour blindness. The final study allows the audience to affect the images and sounds they are perceiving.

Perception is interrogated through practice encompassing aesthetic sensibilities, design principles, artistic notions of colour grouping, colour theory and physiology. Later studies introduce computer programming and sound.

This work seeks an understanding of how distinct visual populations see the world, and to use that knowledge to explore and manipulate their perception of the world, through the medium of art. Additionally, it strives to access others' perceptual worlds. This investigation culminated in the production of art that differentially communicated messages to audiences of differing visual ability, translating those messages between audiences, while simultaneously unifying the experience through sound.

Definition of Perception

A variety of meanings are present for 'perception'. The definition Herbert Read uses in *To Hell with Culture*, is illuminating: 'Either images or symbols or both combined give us a knowledge of the nature of things beyond both our immediate experiences and the structure of the physical world revealed by science' (Read 1963, p. 182). But, Rodulf Arnheim's fundamental assertion in *Visual Thinking* that ALL thinking is perceptual in nature speaks to my use of the word (Arnheim 1969). I will use the word 'perception' in this way; perception is the sensual provision of understanding the world.[1]

1.1.1 Research Questions

The research questions of *Double Vision* advanced in response to the results of artistic practice. Initial and subsequent questions took into account study results, refining the questions to continue progression. That evolution resulted in two interrelated questions that directed the third and fourth studies: *Can artwork be intentionally created to be experienced differently dependent on one's visual abilities?* and *If so, can those experiences be shared?* A last question, *'Can an analogy to colour deficient vision be created that engages both those with CVD and the typically sighted?'*, ends the investigations.

1.1.2 The Research Project

The research project comprises five interrelated visual studies. The five studies are:

> Graphic Design for the Blind: *Can a systematic investigation and codification of sensually expressive textures and shapes lead to a non-visual typography, or a graphic design for the blind?* The requirement for an eager cohort of Braille readers to test proposals overwhelmed its perceptual underpinnings. Although the proposition was flawed, themes were established that continued throughout the research.
>
> Double Blind Test Series: *Can artistic intention be conveyed to the sighted while engaging the blind, the colour blind, and the partially sighted?* This series of twelve prints integrates aspects of the initial examination, moving from the wholly tactile world of Braille into the visual exploration of intentionally varying perceptions.
>
> Colour Blind Test: *Can artwork can be intentionally created to be experienced differently dependent on one's visual abilities? If so, can those experiences be shared?* In this study two diptychs hide visual messages in plain sight then reveal those messages through the use of computers fitted with specially designed software.
>
> Eye for An Eye and Triple Blind: *Can artwork can be intentionally created to be experienced differently dependent on one's visual abilities? If so, can*

those experiences be shared? In this study, the research moves from prints to animation and then moves the animations to prints. It is an assembly of three full-colour motion graphics projected onto black and white prints that investigate the potential of animation embedding differing simultaneous messages to audiences of varying visual acuities. Relying on early movie marque animation techniques, a bespoke musical score accompanies the projections supporting the cinematic allusion.

Ball of Confusion: *Can an interactive analogy to colour deficient vision be created that engages both those with CVD and the typically sighted? Can the addition of dynamic reactive sound enhance the experience?* Ball of Confusion, the motion graphic projection allows the viewer to directly affect how colour is represented and perceived. It is complemented by a colour-controlled soundscape.

1.2 STRUCTURE OF THE THESIS

Following the introduction, the body of this thesis is structured with five chapters; each corresponds to one of the five studies and describes pivotal developmental stages. The art is presented in the order of its evolution to illustrate the progression of processes, concepts and contexts. The investigations required to produce each body of art, i.e. the aims, methodologies and context are described in detail within each chapter. These five chapters are followed by a discussion and conclusions.

1.3 METHODS

Double Vision's lead methodological approach is artistic practice. Other methodologies are employed according to the needs of that practice.

Iteration: Through linking the process between the conceptions of my mind with physical outcomes, creative thoughts were physically crafted, evaluated, refined and re-crafted until conclusions were achieved. Not only were individual works reached through iteration, the successive groups of work explored developmental routes supported by the preceding works.

Collaboration: As the project progressed, lines of enquiry presented themselves which were beyond my expertise. For those, I collaborated with computer scientist David Flatla and sound artist Raz Ullah, in whom I found the skill sets required to complete the research. Each collaboration was pivotal, essentially allowing innovative direction of aspects of the research.

Exhibition: Exhibitions were conducted as a platform for collecting data in the form of audience responses and feedback. With the exception of Graphic Design for the Blind, each body of work was exhibited to the general public. The exhibitions provided an opportunity to communicate directly with audiences and assess the efficacy of the work in its aims. Questionnaires were

provided at two of the exhibitions to compliment my observations.

Testing: Panels of testers were found for each body of work and used to test prototypes. Their responses were noted and adjustments made.

1.4 MEDIA

Art was realized through different media and multimedia expressions.

1.4.1. Print

Printmaking is a natural choice of medium for this investigation. The original proposition was directly related to print, with the application of contemporary typography practices to Braille. Braille itself is the embossing of raised dots on paper. Original investigations included the use of relief printing and screen printed textures. Later research continued the use of relief printing and screen prints, with the addition of ink-jet printing.

1.4.2 Animation

Once the research aims were met with still images, the ability to encode messages to audiences of particular visual acuities in moving images was investigated, both on monitors and as projections onto prints.

1.4.3 Interactive Environments

The final exploration of the research aims was realised in a multimedia interactive environment incorporating projected motion graphics and an interactive soundscape.

1.5 CONTENT AND INSPIRATION

In responding to the research question, concerns regarding the creation of effective and expressive art became evident, centring on the communication of the research intent while expressing unique aesthetic sensibilities. Other inspirations and content were:

1.5.1 Imagery

As a visual project, *Double Blind* relied on imagery to communicate its investigations.

Braille: Developed for the blind and partially sighted in 1809 by Louis Braille in France, Braille is a system of raised dots readable by touch (American Foundation for the Blind 2016). Braille typography development was the original proposition of this body of research. Braille titles and numerals are embossed into twelve prints.

Ishihara's Test for Colour Deficiency: With the exception of *Graphic Design for the Colour Blind*, each of these works relies, in part, on imagery influenced by the Ishihara Test plates. Developed to test for the red-green CVD commonly known as

‘colour blindness’, the Ishihara test plates can distinguish between the two types, protan and deuteran, and determine the severity of each. The circular images on the Ishihara plates are comprised of smaller circles of various sizes with patterns and numbers camouflaged within them. They are familiar to many, having being in regular use to diagnose colour blindness for a century (Ishihara 1917).

1.5.2 Literature
Ideas from interrelated texts concerned with perception played an important role in establishing the themes in the work, too. Additionally, copy from these texts functioned as visual texture in many of the prints and served as source material for the prints’ titles.

1.5.3 Music
Music plays in essential role in *Double Vision*. Lyrics were used as conceptual constructs and visual texture in some of the prints. Songs reinforced themes such as circles, drugs, heaven and hell. Titles of prints and installations directly referenced song titles and lyrics. Two later works, *Triple Blind* and *Ball of Confusion* have their own integrated, uniquely composed soundscapes.

1.5.4 Philosophy
Dualism: Dualism is the philosophical diminution of something into two irreducible parts (James and Stangroom 2013). The art created and the underlying impetuses portray the inherent contradictions in the dualistic perspective, i.e. blind and sighted, colour blind and typically sighted, heaven and hell, up and down, horizontal and vertical, light and shadow.

Supremacism: “Supremacism is the artistic expression of the existence of man in this universe.” (Petrova 2012, 30%) Founded by Russian artist Kazimir Malevich in the early twentieth century, the pinnacle of Supremacism art reduces imagery down to large black or white circles and squares on black or white backgrounds. The imagery figures prominently in multiple prints in *Double Blind Test Series*.

1.6 AUGMENTED REALITY
To facilitate the translation of visual messages between audiences, augmented reality software was developed that uses real-time computer and tablet simulations to share those differing visual experiences.

1.7 SUMMARY
Double Vision is a creative-practice led investigation into perception. Initial investigations concerned tactile perception, but quickly transitioned to visual. Seeking accessible visual variations, red-green CVD and typically sighted audiences were targeted. Five interrelated studies were conducted each building on the outcomes of the previous study. Aims and questions were refined to reflect that evolution.

Using a foundation of visual, literary, musical and philosophical components, artwork was produced in a variety of media in response to the research questions and aims. To comprehensively examine the questions, collaborations were formed and led to the development of augmented reality software and interactive soundscapes. Artwork was exhibited and findings articulated through public lectures and published articles as a means of dissemination, dialogue and further community engagement.

Notes

[1] Interestingly, the definitions of the words perception, aesthetics and science can become intertwined. In Visual Thinking, Aesthetics is 'the science of perception' as defined by Herbert Read in *The Meaning of Ar*t. Rudolf Arnheim postulates that artistic activity is a form of reasoning and that this thinking "ignores the property lines between the aesthetic and the scientific." (Arnheim 1997, p. vi). Arnheim, evades providing a definition of aesthetic in his writings. When pushed for a definition by Paul Rand in an interview, he somewhat reluctantly replies that he looks to Kant, but looking beyond the Kantian idea of perfection, harmony, balance and simplicity, to coherence (Arnheim 1997, pp. 77, 78). If we think of coherence as being "logically consistent", it does not progress the distinction between aesthetic, perception, or even science, very far. Aesthetics = perception = science. Such is the problem of translating creative creation into written narratives. As Barnett Newman famously said: 'Aesthetics is to artists as ornithology is to birds."

For clarity, in this thesis "aesthetics" are my set of artistic principles and fundamentals that underlie my work (or others' work if talking about them).

In the creation of much of the art in Double Vision, I use scientific theories. So, in this thesis, 'science' will be understood as those theories and not the practice of the scientific method itself.

References

American Foundation for the Blind. 2016. Available from: http://www.afb.org/ [Accessed 23 August 2016].

Arnheim, Rudolf. *Visual Thinking*. Berkeley, University of California Press, 1969.

Garvey, J and Strngroom, J. 2013. *The Story of Philosophy: A History of Western Thought*. London, Quercus Editions Ltd.

Ishihara, S. 1917. *Ishihara Test for Colour Deficiencies: 38 Plate Edition*. Tokyo, Hongo Harukicho.

Petrova, E. 2012. *Malevich's Suprematism and Religion (Kazimir Malevich: Suprematism)*, Kindle Edition, New York, Guggenheim Museum.

Read. Herbert. *To Hell with Culture*. London, Routledge, 1963.

GRAPHIC DESIGN FOR THE BLIND

2.0 STUDY ONE: GRAPHIC DESIGN FOR THE BLIND

Study One consists of five sections: an introduction to the study, three responses to the research question and the findings.

Research question: *Can a systematic investigation and codification of sensually expressive textures and shapes lead to a non-visual typography, or a graphic design for the blind?*

2.1 THE IMPETUS

The motivation for exploring a texturally expressive Braille came from my own experiences moving from classroom teaching to an online environment, where I found it difficult to effectively communicate with my students. Much of the online classroom consisted of students posting images of their work and me making typewritten comments on it. I wrote much like I talked. Students often found my comments curt and overly critical, which for the most part was not my intent. I quickly realized that whilst my written words were similar to my spoken ones, the typed words did not convey my intonations, facial expression or body language. I tried to solve that problem by starting my written comments with “well done” or “good job” followed by exclamation points and emoticons to convey mood. Soon my typewritten critiques looked like texts from teenage girls. While my students warmed to my comments, I could not stand them. The problem was solved by recording critiques as audio and video clips. This worked well. Students were able to hear and see me and understand the nuance of my comments.

stop

Alphasignal is the hard data or primary facts and figures of a communication. It carries the objective part of the message.

STOP

Parasignal designates a mode of signal that travels alongside the alphasignal to amplify and support it. The capital leters and bold sans serif typface reinforce the primary message.

Figure 2.1

As a lecturer of graphic design, this experience affected me profoundly. While solidly understanding visual communication from a design perspective, its meaning now included personal interaction. I realized that for some time I had mistaken talking for communication – what I communicated relied heavily on the sights and sounds I created alongside my words. Stripping out those elements, as happened in my online communications, exposed the starkness of my words.

This realisation led me to reflect on typography and the way that it enhances written communication through arranging type to enhance meaning. For a long time in typography, meaning meant legibility. Expression replaced legibility in typography through the work of graphic designer David Carson's "grunge typography" (Carson 2012). Carson is famously quoted: "Don't confuse legibility with communication." In his pursuit of expression Carson laid out a particularly boring interview entirely in Dingbats (Wolfson 2015).

I think one of the best explanations of how graphic design and typography communicate meaning is Crawford Dunn's Signal Theory.

2.1.1 Signal Theory

An important attempt to develop a theory of graphic design as communication, Signal Theory defines three distinct modes of communicative signals (Dunn 1970).

Alphasignal is the hard data or primary facts and figures of a communication. It denotes the first or primary information carried. Dunn believes that telephone directory listings, stock market quotations, and computer

wedding

Wedding

Figure 2.2 Parasignals support and enhance the alphasignal. Elegant script type conveys the importance and grandeur of the occasion.

Figure 2.3 Infrasignal is information underlying or beneth the message. If a community installed traffic signs like those on top, motorists would know that they were not "official" traffic signs and might ignore them.

display data are all pure alphasignal. "Alphasignal, then we may say, carries the objective part of the message, without inflecting, without emphasizing, without editorializing, without reinforcing, without propagandizing, maximizing or minimizing, in short, without rhetoric" (Dunn 1970, p. 22). I saw this as my own typed communication to my online students.

Parasignal designates a mode of signal that travels alongside or at the side of the alphasignal, to amplify and support it. On a stop sign, the bold capital sanserif letters have become accepted through traditional usage as parasignals that support and enhance the alphasignal (Figure 2.1). Dunn points to the elegant script type and fine engraved printing used on wedding invitations as an example of a parasignal, intended to convey the importance and grandeur of the occasion (Figure 2.2).

Infrasignal is the message conveyed by the relationship of the alphasignal and the parasignal. It is information that can support or betray the sender. If a planned community installed traffic signs as shown in the upper image of Figure 2.3, motorists would know that they were not "official" traffic signs and might even ignore them. While the white and red colours are appropriate and the word STOP is the proper alphasignal, the inconsistencies of the hand lettering convey a parasignal that is at odds with its anticipated authoritative function. Giving the appearance of authority such as the sign in the lower image, with its manufactured uniformity, increases the likelihood that others will comply with requests. When people are uncertain, they look outside themselves for information to guide their decisions (Cialdini 2007). The sign in the upper image lacks that authority. The

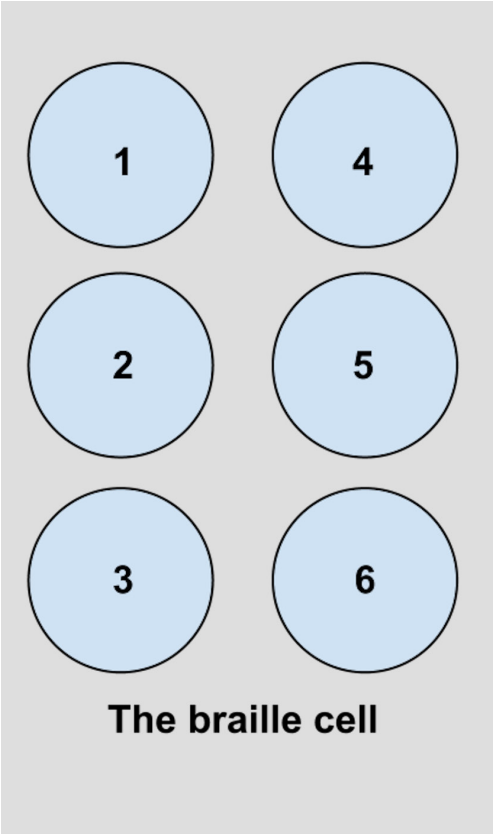


Figure 2.4 Braille dots are numbered 1, 2, and 3 from the top of the left column and 4, 5, and 6 from the top of the right column resulting in 1 being in the upper left hand corner of the Braille cell, 4 to the right of it and 2 below it.

authority of the sign in the lower image is its infrasignal.
Graphic Design for the Blind was intended to make Braille not more legible, but more expressive. It aimed to layer additional meanings onto Braille's rigid format, through conscious application of para signal messaging. It was to introduce Braille to late 20th century typography.

2.1.2 Braille

Braille is an example of information conveyed by way of Dunn's Alpha Signal. Its constructions of gridded dots are absent of the ornamentations of typical typeface design - serifs, ears, spurs, tails, terminals, etc. – and convey only pure information. Even italics in Braille are designated by an additional Braille cell, preceding the text (National Federation of the Blind, 2015). Imagining a typographical Braille, one that had its own versions of letterform expressiveness and that could be incorporated into a new dynamic tactile typography, was the beginnings of a graphic design for the blind.

Braille was developed to code wartime messages. The tactile writing system of Braille is used by blind and partially sighted people, but its history can be traced back to Napoleon and his demand for a silent communication system that could be used without light (American Foundation for the Blind 2016). "Ecriture Nocturne", a code of raised dots on paper, was developed by Charles Barbier in response.
Using "Ecriture Nocturne" as a starting point, Louis Braille developed his system in 1824 whilst a 15-year-old student at the National Institute for Blind Youth in Paris, France.
For the Braille cell itself, most dimensions are slight variations set by the Perkins mechanical writer which, on introduction

in 1951, set the standard for Brailling (American Foundation for the Blind 2016).

Braille is standardised by codes. In 2015, the United Kingdom introduced the use of the Unified English Braille code (UEB) joining other major English speaking countries in its use. UEB unifies the designation of letters and symbols to the Braille cells. (Royal National Institute of Blind People 2015). This move to standardisation helps ensure universal legibility of English language Braille documents produced in different countries.

Each Braille character, or cell, consists of six raised dots arranged in a grid of two dots horizontally by three dots vertically (Figure 2.4). The presence or absence of dots gives the coding for each symbol. Codified, exacting specifications have been developed for Braille, including measurements for dot width, height, cell to cell spacing, line to line spacing and line lengths (Braille Authority of North America 2017).

As a result of technology and educational priorities, Braille use is in decline (National Federation of the Blind 2015).

To ensure I was not misunderstanding the nature of Braille, in October 2010 I contacted Tara Annis, Information Specialist at the American Foundation for the Blind, and asked her about the expressive nature of Braille as understood through Signal Theory. Her detailed email response on 19 October confirmed it was “correct that braille is alphasignal, providing the hard facts of the text”. She continued; “The broad parasignal repertoire of visual design is almost completely absent, although some methods to convey basic formatting do exist”.

I aimed to layer addition meanings onto Braille’s rigid format, through conscious application of para and infrasignal messaging. With Ms Annis’s conformation that Braille was essentially alphasignal my proposal for a “graphic design for the blind” was launched.

2.2 INITIAL INVESTIGATIONS

Initial investigations concentrated on two parallel lines of enquiry: First, developing print techniques that generated tactile output usable for the raised surfaces required by Braille, and second, gauging the reactions of a potential audience of Braille users to the concepts and techniques of *Graphic Design for the Blind*.

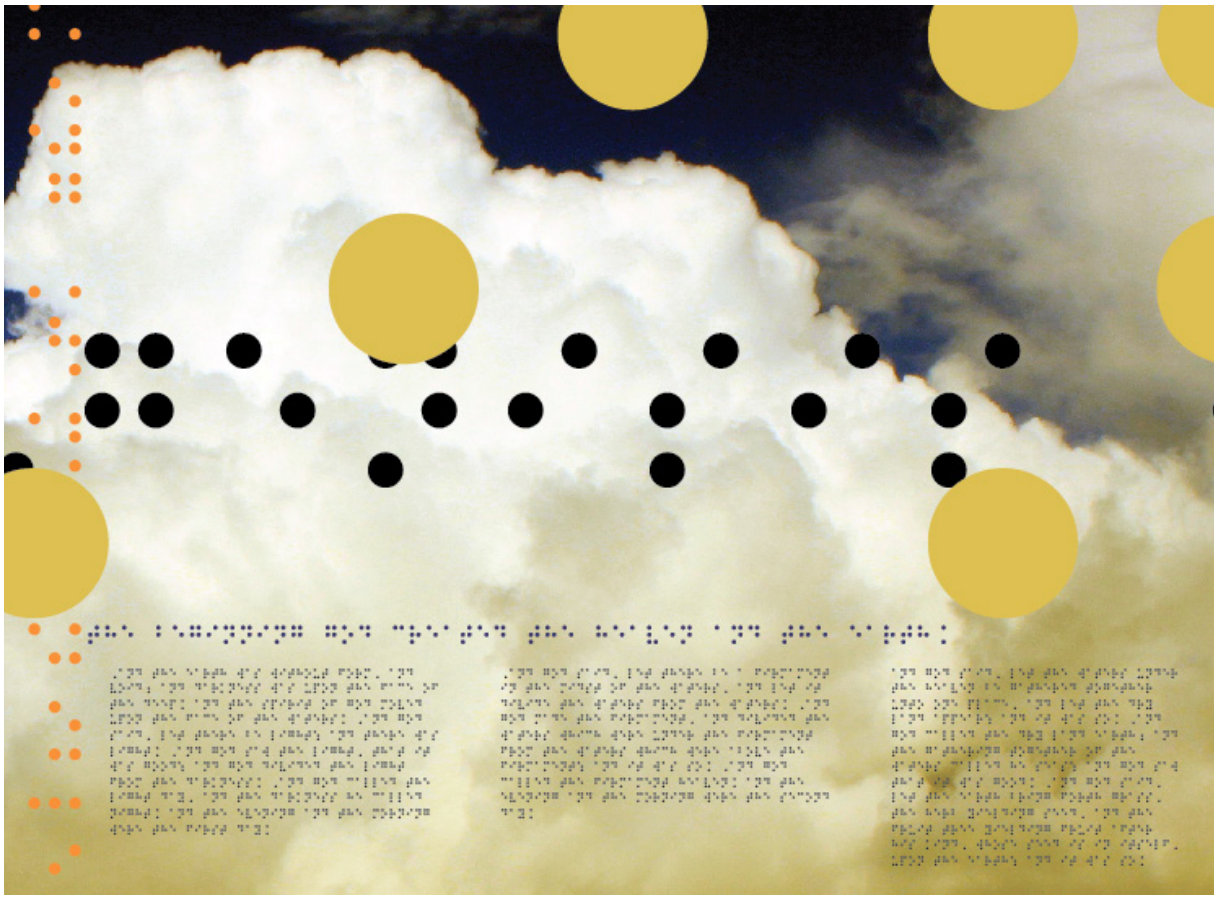
Just as various typefaces can convey different messages, as described in Dunn’s signal theory, I hypothesised that different dot textures for use in Braille would convey different messages. Imagining that flocked dots would convey warmth and familiarity while puff-ink dots would communicate litheness and durability, I conducted experiments looking to build a tool box of techniques to produce a

Figure 2.5 When heated to a high temperature, the puff ink puffed.

library of codified textures that I could incorporate into Braille that would enhance its reading experience.

To produce these varying t
extures, presses, substrates and papers for embossing were tested. Experiments were conducted with screen printing and flocking, trying out different meshes and adhesives including clear bases and PVA glue. Flock was applied in different ways, floating it on, blowing it on and building a box to shake it on, all to varying degrees of success. Screen meshes as high as 140T and as low as 43T were experimented with.

Different puff inks were tried, varying the amount of puff base to ink base and pigment. To puff, the screened-on puff ink has to be heated to a high temperature. Although a heat gun was sufficient when working with small A4 sized areas, with larger areas, like the 60 x 90cm prints I hoped to create, the ink would begin to set before being adequately heated. The studio's automated print dryer could have been ideal, had the temperature setting generating the desired results not also set off the building’s fire alarms (Figure 2.5).



In the Beginning, 71 x 91 cm flocked silk screened ink-jet print, 2012.

2.3 IN THE BEGINNING

In the Beginning was the first print created in response to the research question.

2.3.1 The Print

The size of the print is 60 x 90 cm. A large colour image of clouds and sky that bleeds off the paper is the background. The blues of the sky are rich royal blues and the shadows within the clouds are shifted to yellows. The text, set in Braille, is taken from the first chapter of Genesis. The first word, 'In" is typeset so large that it is slightly cropped left to right by the page edge. It is printed in yellow flocking. Then, 'the beginning' is typeset behind it in dark blue puff ink, moving from the left edge of the page to the right edge. "God created the heavens and the earth" is typeset vertically, reading from top to bottom, near the left hand edge in orange flocking. "And the earth was without form, and void; and darkness was upon the face of the deep" is laid out using the dark blue puff ink in the lower third of the composition going above three columns of texts. The three columns of text, set in standard Braille and printed in blue puff ink contain the remainder of the first chapter of Genesis.

2.3.2 Development

The first historical piece of Western typography was Gutenberg's Bible, created with his newly developed movable type, press and inks. Considering my work a

continuation of typography's development, I began work on two sets of print layouts, both based on creation stories of the Bible: the first, Genesis 1, "In the beginning God created heaven and earth"; the second, John 1, "In the beginning was the Word". That seemed relevant to the work I was doing - two different typographies, one that I taught for the sighted and one that I was going to develop for the blind. I had in my mind that I would explore why the 'Word was with God, and the Word was God", but because of my own blind spot, the second print and my exploration of its meaning remains unfinished.

Inspired by success of some of the textural experiments, I finalized the design and commenced printing the *In the Beginning* layout. The work was intended to be transitional, incorporating traditional graphic design while beginning to explore a graphic design approach appropriate for Braille.

The final layout for *In the Beginning* relies on colour and photographic imagery. I aspired to create a piece that communicated interestingly to both the sighted and Braille readers. The photograph of close cropped sunlit clouds against a blue sky was directed to the sighted, as were the yellow and orange colours used on the oversized Braille letters, intended to visually enhance the opening notions of the text. The use of oversized flocked Braille text and standard size Braille in puff-ink relief were the first forays into Braille graphic design, with the intention of creating a dynamic and sensually appealing reading experience communicating a tactile hierarchy based on size and texture.

The entire image was inkjet printed through an EPSON Stylus Pro 9800 using Ultra Chrome K3 inks onto Somerset enhanced velvet 100% cotton paper. In moving the print to the next phase of printing I realized that I had made a rookie mistake. I had envisioned texturing the Braille of the print using two approaches. The first was using screen printed puff-ink for black text on the main body set in Braille characters. The second screen printing varnish was to act as adhesive for yellow and orange flock applied to the exaggeratedly large Braille used for composition and visual emphasis. As I was preparing the screen for the puff-ink, I remembered if a texture is created on a piece of paper from printing, that texture would almost certainly be flattened should same piece of paper be printed onto again. That meant that the first texture, in this case the puff-ink, would either interfere with the printing of the varnish for the flocking or interfere with the printing and not let the varnish properly or accurately pass through the screen onto the paper. The same thing would happen if I moved from one colour of flock to the next. The flock already in place would be flattened by the process of adding another colour of flock or would interfere with the printing of the second colour. I decided not to use the puff-ink and eliminate the orange flock, leaving only the yellow flock as texture.

The largest of the Braille dots, those in yellow, were screen printed over with varnish using a 120 mesh. While still wet, each print was put into a shallow box filled with

orange flock and the box was vigorously shaken to distribute the flock onto the print. The print was removed and allowed to dry while the next was screen printed and flocked.

The run was small, fifteen, of which seven made it through the entire flocking process. Even with my mistakes, I was pleased with the look of those seven. I touched the prints to see if I could easily differentiate between the smoothness of the paper and the velvety-ness of the flock. I could, but the light touch of my finger easily separated the flock from the varnish. The varnish was strong enough to hold the hold the flock in place as long as it wasn't touched. The print that was to be my initial exploration of an expanded Braille typography was unreadable by both the sighted and the blind.

2.4 GAUGING AUDIENCE RECEPTIVENESS: THE DUNDEE BLIND AND PARTIALLY SIGHTED SOCIETY

During this time, arrangements were being made with the Dundee Blind and Partially Sighted Society to meet with members who were Braille readers but due to schedules there was some delay in those meetings taking place.

The Dundee Blind and Partially Sighted Society was the primary resource I accessed to test my early ideas. The Society, started in 1879, has around 1,200 clients whose ages range from children to centenarians (Dundee Blind and Partially Sighted Society 2015). Doreen McNab, Rehabilitation Officer at the Society is typically sighted but experienced in reading Braille.

I met Doreen at this initial stage of my research to discuss some of the practical aspects of Braille and my project proposal, and to arrange further meetings with blind Braille readers in The Society. Doreen explained the differences between Grade 1 and Grade 2 Braille, (Grade 2 Braille relies on contractions to aide reading speeds and produces less bulky books and magazines) and expressed doubt that my project would generate interest with the clients at the Blind Society. Nonetheless she arranged for me to meet with two activity groups at the Society.

2.4.1 History Group

The History Group meets weekly to discuss local and Scottish history. Of the six elderly members, two read Braille. One was a woman totally blind from shortly after birth who had only ever read in Braille. The other was a man who had very limited sight, able to partially see things when very close to his eyes, and who had been taught Braille during his time at a school for the blind. Both talked about the difficulty of learning and reading Braille. The woman talked about the concentration needed when reading it and of how the legibility of Braille printed on a page degrades with each reading. She said she only read Braille when on her own in a quiet place. The man talked about his continued resistance to reading Braille. He said that reading with the very limited sight that he had was less difficult than reading Braille. He

speculated that anyone with the visual ability to read, no matter how limited, would do so rather than use Braille. The others in the group, who had age related vision conditions including macular degeneration, agreed, providing anecdotes of other Braille readers. They were uniformly uninterested in my ideas about enhancing Braille.

2.4.2 Crafts Group

A week later I met with the Craft Group. The group comprised eight welcoming members whose ages ranged from mid-twenties to mid-seventies and were led by Anne, a local artist volunteer. Their disabilities varied from complete blindness to mid-stage macular degeneration. Two of the members were also deaf. The group meets to craft individual projects, to work on occasional group projects and to socialize. I presented my ideas about enhanced Braille to them, doing so in a way that related to making art and crafts. With etching and intaglio plates, embossments and fabrics of various textures as examples, I talked about texture as expression and asked what emotional responses different textures might elicit. The response to my ideas about texture and expression were well received, but of even more interest was how images were transferred from plate to paper, reinforcing my exploration of printmaking and creative practice. But once put into the context of Braille, interest waned.

Because of declining funding and advancing technology, most Braille readers are of an older generation, the generation of modernity, the generation of “less is more.” For them, Braille is a tool of communication of the most basic level. In my original approach to this project, and maybe as a result of being from a post-modernity generation, I wanted Braille to communicate “more”. I wanted to create a system for Braille that paralleled contemporary typography. Their response was negative. Form follows function. Braille does what it needs to do. No improvement is needed. It came as a revelation to me. I had proposed to them a solution for a problem that did not exist. But, luckily that did not deter me from forging ahead.

FIgure 2.8 *Lassie* (detail) , A4 Xerox, 2012

2.5 CRAFTS GROUP INVESTIGATIONS

The items produced by the craft group were visual in nature. I thought that texture might be a substitute for diminishing or absent sight. In my mind, the Craft Groups desire to continue to create visually was vestigial, that it was some kind of hard to let go habit, a phantom limb of absent sight.

2.5.1 Colouring Pages

The Craft Group made things. Much of this was commercial craft products such as models, pre-printed needlepoint patterns and macramé kits. As an artist and educator, I was able to offer alternative crafts and projects. Through conversation I discovered that many in the group expressed a keen interest in pop culture and celebrity. It was requested that I create high-contrast, celebrity influenced images that could be coloured in. Colouring pages were laid out - pastiches influenced by and appropriated from popular culture. Pop Art influenced, black and white representational images of Elvis, Lassie, the Queen, Simon Cowell and Daniel O'Donnell were created (Figure 2.6). It wasn't a far stretch from some of my past illustration work. Many copies were produced and group members enthusiastically coloured them in (Figure 2.7). Visually recognizable imagery was important to this group.

2.5.2 Fabric Collages

Along with the colouring pages, we also worked with fabrics to create texture-based collages. Members of the Craft Group and I went to thrift shops and bought inexpensive clothes in interesting fabrics, colours, patterns and textures. Three of the group members explored the different colours, patterns and textures. Pleased with their first collages, two of the members continued on with the project creating

Figure 2.7 Craft group members coloured the pages.

Figure 2.8 Members of the craft group worked with fabrics to create texture-based collages. Texture of the fabric was subservient to its visual representation with only the fabric fur used on the dog being representational.

multiple compositions, including images of dolphins, dogs, jaguars, horses and flowers (Figure 2.8). While some of the fabric choices were texturally representational, e.g. fur-like fabric was used for the body of a terrier, the collages were very visually representational using colour and contrast to create the imagery and differentiate between the subjects and backgrounds. The sea was green, and the dolphin grey. The white terrier with a red collar stood out against green grass and blue sky. The jaguar had spots. While the textures of the fabrics were interesting, only the fabric fur used on the dog was texturally representational. It was clear from the results that the texture of the fabric was subservient to its visual representation.

2.5.3 Printmaking

The next alternative project I arranged for the Craft Group was a printmaking workshop, organized with the Community & Education Coordinators at Dundee Contemporary Arts, Initially, printmaking was introduced as means of creating textured surfaces but as the Craft Groups preference for visually imagery became apparent the more accessible techniques of monotype printing became appealing. The aim was to help them create monotype prints.

This printing technique is appropriate because it introduces various aspects of printmaking;

- The transfer of an image from a plate to paper using a press.
- The idea of process playing a part in image creation.
- The use of inks and rollers.
- The reversal or mirror image from the plate to the paper.
- The use of a printing press.

Beginners get an understanding of many of the basics of printmaking without being overwhelmed by the techniques and processes that comprise other specific printmaking approaches.

Two advantages of many other forms of printmaking are sacrificed in monotypes. One is that many monotype approaches only transfer ink from the printing plate without the textural change to the paper that occurs in other techniques such as engraving, intaglio and relief. In those techniques surface areas of the plate are removed creating a plate surface that has variable depths. Those variations are transferred to the paper in the printing process, giving the surface of the paper tactile variations. While it was an initial consideration of mine, the Craft Groups indifference to texture eliminated this consideration (Rothstein 1966).

The second is the monotype printing process produces one unique print. Monotypes can be thought of as directly printing paintings and drawings onto paper. They require the application of ink to a blank plate, or substrate, that is then run through a press onto paper. The image is transferred from the plate onto the paper in a mirror image. Other printing making processes allow for the editioning, or the creation of multiple indistinguishable prints. Time is taken in working the plates, stones or screens that print the image, and those plates, stones and screens can be used over again to produce the same image. Much time is taken to create the plates, stones and screens. Monotypes can be created in a much shorter time and fit within the 2-hour Craft Group weekly meeting (Marsh 1973).

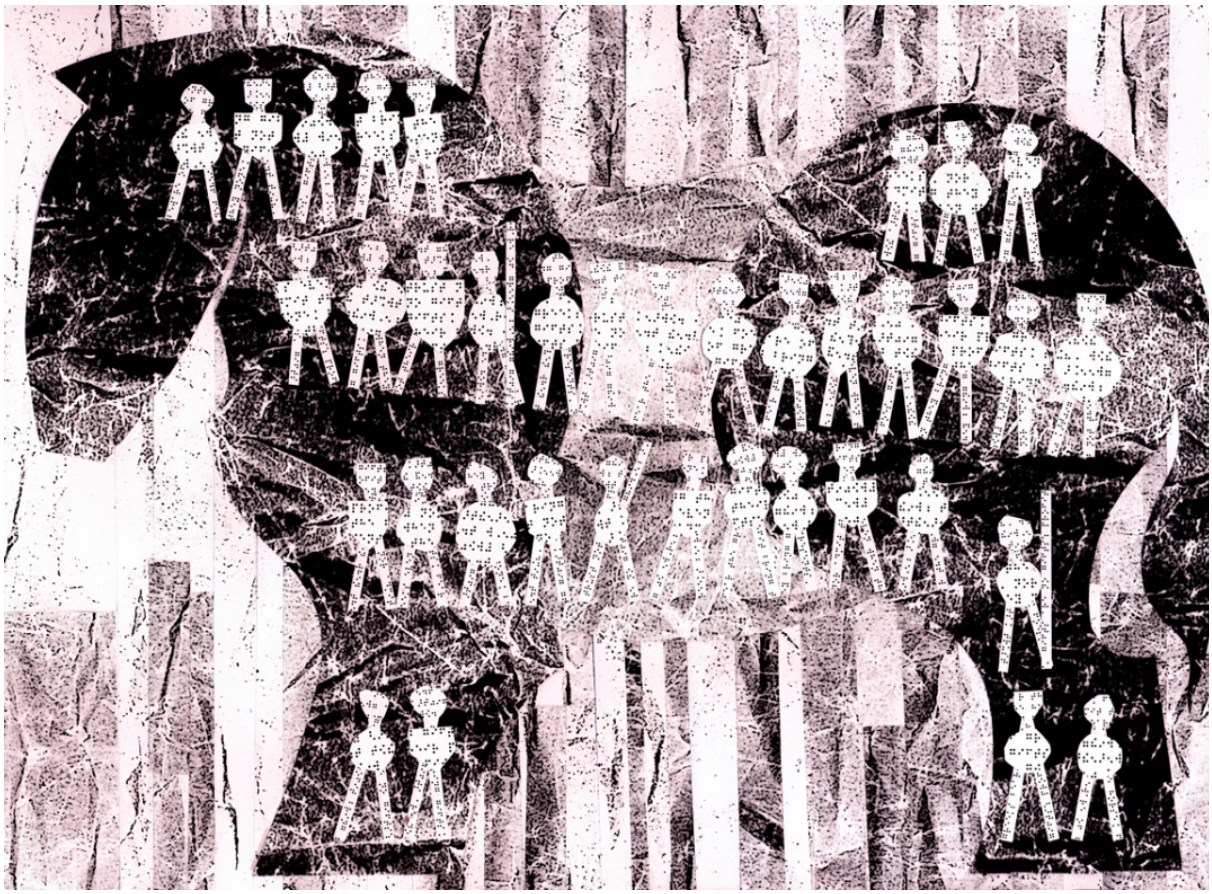
Various techniques can be used in the creation of a monotype. The additive approach requires the addition of inks to the plate to create the image. This can be done through painting or drawing with ink onto the plate or through rolling on the ink, which produces an even coating. The subtractive approach requires the plate to be covered in ink and the image created through the removal of ink in areas.

In relief printing, the surface of the plate is inked leaving the removed surface areas ink-free. The inked plate, covered with a sheet of paper, is run through a press resulting with the paper being inked by the surface of the plate and the un-inked areas raising those areas on the paper from the act of being pressed into those removed areas of the plate (Marsh 1973).

The workshop took place over two hours in the Activity Room in at Dundee Contemporary Arts (DCA). A long table was set up with primary, secondary, brown and black Speedball inks, rollers and paper used for stencils. The facilitators, myself included, helped with generating ideas for imagery, cutting stencils and inking plates where needed. But for the most part the Craft Group members created their prints with little help once the process was explained to them. Each Craft Group member created at least one monoprint and was generally positive about the experience. Subjects of the prints included representational landscapes, animals,

flowers and one abstract composition. All were vibrantly coloured, with colour being used for contrast
(figure 2.9).

Figure 2.9 Each Craft Group member created at least one monoprint.
All were vibrantly coloured with colour being used for contrast.



Trojan Horse, 24" x 35" screen print, 2012

2.6 TROJAN HORSE

The Trojan Horse is not what it appears. Its function is hidden by its form. I developed this print as my original idea of an enhanced Braille became functionless. As with the Trojan Horse, I knew that there was something locked inside my idea about a *Graphic Design for The Blind*, but at this point I did not know what it was.

The continued interaction with the Craft Group resulted in rethinking the direction of my project. On viewing a presentation of my work with the Blind Craft Group at a Duncan of Jordanstone College of Art and Design research forum, Graham Pullin, author of Design Meets Disability forwarded me a chapter of his book, in which he observes: "Braille is interesting and beautiful, as abstract visual and tactile decoration, intriguing and indecipherable to the non-reader". He continues; "... braille could be decorative for sighted people" (Pullin 2009, p. 241).

Braille for the sighted was intriguing. Not so much as decoration, but as a signifier of intent - Braille could be both the indication of hidden information and that hidden information itself. Braille is not used to communicate to the sighted, but those with sight know on seeing it that information is coded within it. In a twist to Crawford Dunn's ideas on typographical communication, the setting of text in Braille subverts its parasignal. To the sighted, Braille communicates that there is information while at the same time obscuring its meaning.

In The Beginning, my first print, used Braille to engage both the blind and the sighted. The Braille varied not only in size and texture, but also in colour and layout. In *Trojan Horse*, the freedom of using Braille as a visual element for the sighted, without needing it to be a practical communication tool for the blind, provided additional insight to re-evaluate the objectives of the original line of enquiry in *Graphic Design for the Blind.*

2.6.1 Braille as Art

To understand the potential of this approach, I looked to other artists who used Braille as a visual element.

The use of Braille in art has been explored with some vigour. In France, at the time of this writing, there is “The Blind”, a sighted graffiti artist who practices his graffiti with half spheres of plaster and a glue gun (Fichou 2013). In 2013, In San Francisco, Richard Bassett exhibited a series of Braille prints that used shaded Braille dots to create visual texture (Kanevsky 2013). As early as 1991, Barbara McCarren exhibited in California ‘Mute’, a white light Braille poem projected into a dark room (McCarren 2010).

Two contemporary artists using Braille in their work stand out; Anton Parson and Chen Young. Anton Parsons’ public sculpture for Wellington, New Zealand uses very large scale raised Braille dots. Parsons use of Braille leaves his impressions of the city written in Braille unreadable to the Blind and indecipherable to the sighted. Chen Young uses two-dimensional Braille and the female form to explore the connection between sight, touch, function and desire. With Chen's work, you can look but you cannot touch. Present in both works is mystery. The sighted cannot perceive the message because Braille is not a communication tool of sight. The blind cannot perceive the message because of scale and convention.

Anton Parsons’ 2003 *Invisible City* sculpture comprises two vertical stainless steel slabs, 2600 x 1350mm. The slabs are covered with a poem written in an oversized half-sphere raised Braille. The twin monoliths, reminiscent of two pages of a book or a doubling of the ominous black form from 2001 a Space Odyssey, were created in collaboration with blind poet Peter Beaston (Parsons 2003). Beaston’s writings about his journeys around Wellington cover the slabs in large, raised Braille (Figure 2.10).

The Braille dots themselves are compelling. They are large, becoming obvious as Braille only when viewed from a distance which is too far away to be touched. The scale of the Braille leaves it illegible to the close examination required by a blind Braille reader. Braille makes the message hidden or disguised to both the blind, who cannot read it because of its scale, and the sighted, who cannot read it because of its format. Although the message is visible, its scale renders it hidden in plain sight.

Figure 2.10 Invisible City Anton Parsons, 2003, Stainless Steel, 2600 x 1350 cm.

Figure 2.11 Installation, Chen Young, 2006

In a 2006 installation by Chinese artist Chen Young, an otherwise nude woman covered with adhered two-dimensional black dots arranged as Braille characters, reclines on a backlit translucent glass table. The plastic blackness of the dots contrasts against the skin of the woman and the light emanating from the table (Van Gelder 2006). One is invited to look but not touch. It is reported that security guards had to intervene on several occasions to evacuate people pretending to be blind from reading the braille (Beautiful China 2016).

In a companion piece, an otherwise naked Braille covered woman lies on glass examination table as the hands of six men in white shirts and black ties examine her spotted body (Shen 2016). Again, in these pieces, Braille hides its message to both the blind and the sighted. But, here the Braille invites touching, inappropriately in the first instance and disturbingly clinically in the second. Again, as with Parson's work, the message is visible but because of its format it becomes secret (Figure 2.11).

Both Anton Parsons' and Chen Young's work, are directed at a sighted audience. The Braille dots' size or their flatness make them unintelligible to the blind reader. The Braille is also illegible to the sighted. But, the dots do tell the sighted that there is information there to be decoded. That the message is camouflaged. It is a challenge to the viewer to discover why the message has been hidden and what that message is. I endeavoured to make a print that used Braille to explored those challenges.

2.6.2 Bearing Gifts

The troubled financial situation of Greece at this time suggested the theme of a Trojan Horse to me. The news reported on the

extensive damage that Greece could have on the European economy (Elliot 2010). I used my previous mentor Dean Meeker's 1954 *Trojan Horse* print as inspiration. The screen print's boldly drawn cross-sectioned horse reveals hidden soldiers. The horse itself occupies almost the entire page. Its torso is exaggeratedly large holding the well-armed Greeks. These soldiers are arranged on multiple levels within the horse. It is a one colour print, black ink on gold foil paper (Figure 2.12).

In creating my own *Trojan Horse*, I begin to move away from exploring the graphic design possibilities of Braille, to Braille being used as a visual, compositional and conceptual element. The burnt amber coloured screen print is 60 x 88 cm. The page is dominated top to bottom and left to right by a roughly textured, simplified, stocky side-view of a horse. The background is a series of narrow vertical variably textured strips. The interior of the horse is divided into four levels, each filled with simple white figures holding shields, swords and lances. The figures themselves are covered in Braille. The Braille itself is cut sections of the repeated text, "'beware of Greeks bearing gifts".

Figure 2.12 Trojan Horse, Dean Meeker, 1954. Serigraph on paper, 50 x 66 cm.

The Braille was not just decorative but it added meaning. The message to not trust the intentions of the Greeks was at the same time revealed through the use of Braille, and hidden because the illegibility of the not raised Braille dots. While the message was there to be seen, it was unreadable by both the blind and the sighted.

Whilst visible, the message was obscured by its form. It was a secret message, used in a way much like Braille's Napoleonic origins.

Braille contained in *Trojan Horse*, while strongly reminiscent of the unintentionally unreadable Braille of In the Beginning, is intentionally employed to enhance the secrets of the enclosed cargo. The message remains secret even though we can see it. *Trojan Horse* is a transitional piece. It transitions Graphic Design for the Blind to The Double Blind Test Series by shifting intention. It moves from the practical (the creation of an enhanced communication tool) to the exploration of the perception of the presented. It is the beginning of investigation into the contradictions and limitations of visual perception asking questions such as 'are the things of the perceived world manifest to us through experience?' (Merleau-Ponty 2004).

The peculiarities of perception are the embedded message of *Trojan Horse*. Its intended audience moves away from the blind while still using Braille. With *Graphic Design for The Blind* an enhanced Braille was intended to communicate more information than it currently does. In *Trojan Horse*, Braille is used to communicate that there is information presented that is not perceived.

2.7 FINDINGS

With *Graphic Design for the Blind*, I proposed a solution for a problem that did not exist. I made an assumption that the blind might desire an expanded tactile vocabulary for Braille. But their visual, rather than tactile, exploration of textured samples communicated that sight in whatever capacity was the dominant sense.

Because of my interactions with the craft group I had critical issues to think about in refining the project. The lack of interest in Braille, the comfort of the recognizable, the importance of colour in establishing contrast and the supremacy of the visual image were all things that I needed to contemplate.

In the process of reflection, related lines of potential enquiry became evident. While there was no local interest in enhanced Braille, decorative Braille allowed me to broaden my original audience. Themes of religion engaged me as did print and printmaking. Hidden and camouflaged messages presented themselves as ripe for investigation. How and who might reveal or perceive those messages became intriguing. Taken together, these ideas formed the basis of a plan for continued research.

My first significant refinements developed in response to *Graphic Design for the Blind* are detailed in Chapter 3.

References

American Foundation for the Blind. 2016. Available from: http://www.afb.org/ [Accessed 23 August 2016].

Beautiful China. 2016. Available from: http://www.cin-tv.com/beautiful_china.htm [Accessed 15 January 2016].

Braille Authority of North America. 2017. Available from: http://www.brailleauthority.org/sizespacingofbraille/sizespacingofbraille.pdf [Accessed 20 May 2017].

Carson, D. 2012. *The End of Print: The Grafik Design of David Carson, 2nd Edition*. London, Laurence King Publishing.

Cialdini, R. 2007. Influence: *The Psychology of Persuasion*. New York, Harper Business.

Dundee Blind and Partially Sighted Society. 2015. Available from: http://www.dundeeblindsociety.org.uk [Accessed 6 November 2015)].

Dunn, C. 1970. Alphasignal, Parasignal, Infrasignal: Notes Toward a Theory of Communication". *Print* (November/December).

Elliot, L. 2010. European debt crisis pitches Germany against Greece. *The Guardian*, 10 February 2010.

Fichou, C. 2013. *A Different Touch Of Urban Art: Graffiti For The Blind.* Available from: https://www.worldcrunch.com/culture-society/a-different-touch-of-urban-art-graffiti-for-the-blind/c3s12126 [Accessed 23, June, 2013].

Kanevsky, A. 2013. *Braille art by Richard Basset.* Available from; http://www.artbusiness.com/1open/020713.html [Accessed 2 July 2013].

Marsh, R. 1973. *Monoprints for the Artist*. London, St Martin's Press, London.

McCarren, B. 2010. Available from: http://www.feldmangallery.com/pages/artistsrffa/artmccarr.html [Accessed 10 Sept 2016].
Merleau-Ponty, M. 2004. *The World of Perception*. Abingdon, Routledge.

National Federation of the Blind. 2015. *Lesson 15: Typeform Indicators, Small Capital Letters, Ellipsis, Quoted Material, More on the Standing Alone Rule, More On Braille Translation*. Available from: https://nfb.org/images/nfb/documents/pdf/lesson15.pdf [Accessed 29 October 2015].

Parsons, A. 2003. *Invisible City*. Available from: http://www.sculptures.org.nz/tours/lambton/invisible-city [Accessed 20 May 2017].

Pullin, G. 2009. *Design Meets Disability*. Cambridge, MIT Press.

Rothstein, M. 1966. *Frontiers of Printmaking*, London, Reinhold Publishing Corporation.

Royal National Institute of Blind People. 2015. Available from: http://www.rnib.org.uk/ [Accessed 29 Oct 2015].

Shen Jingdong Imagine Gallery. 2016. Available from: http://www.imagine-gallery.com/artists/cheng-yong/statement/ [Accessed 15 Jan 2016].

Van Gelder, L. 2006, *Cheng Yong*, The New York Times. 18 December 2006.

Wolfson, S. 2015. Why we love Zapf Dingbats. *The Guardian* (10 June 2015).

DOUBLE BLIND TEST SERIES

3.0 STUDY TWO: DOUBLE BLIND TEST SERIES

Study Two consists of twelve responses to the research question each expressed as a print. It begins with an overview of *Double Blind Test Series* and is followed by a description of the initial approaches to the study. Developments, aesthetics, themes and techniques either relevant to the entire series, or to multiple prints, are discussed along with their conceptual underpinnings in these first two sections. Topics specific to particular prints are discussed in eleven following sections, each dedicated to one or two prints in the series. The exhibition of *Double Blind Test Series* and a synopsis of *Field of Vision*, a panel discussion held in conjunction with the exhibition on art, design and games for the visually impaired, comprise the chapter's final sections.

3.1 OVERVIEW

This line of enquiry is the descriptively and ironically titled *Double Blind Test Series*, representing my investigation of communication transitioning from the blind to those with more typical sight, represented here with imagery influenced by the *Ishihara Test*.

3.1.1 Revised Research Question

Double Blind Test Series is twelve 84 x 112 cm prints relying on imagery influenced by the *Ishihara Colour Blind Test* layered with Braille text and textures created from literary texts. The series was created in response to the blind alley that was *Graphic Design for the Blind*. Visual perception, which began with the *Trojan Horse*, emerged as the central theme of the series underpinned by a new question; *Can artistic intention be conveyed to the sighted while engaging the blind, the colour*

blind, and the partially sighted?

This line of investigation was developed during reflection on the experiences with the Arts and Crafts Group, and the idea of Braille as a decorative element. Brought to mind were Braille's origin as a wartime secret code along with other images that explore sight and perception: the black and green American flag after-image (Figure 3.1); the Op Art of Victor Vasarely with its play of foreground and background, positive and negative; and most importantly in the development of my work, the *Ishihara Test for Colour Deficiencies* that I took in grade school with its strangely compelling painterly design. As a compositional element, it reinforced secrecy and hidden messages in the interpretation of the Trojan Horse. More importantly, it was the first step using Braille as a symbol or signifier of visual perception.

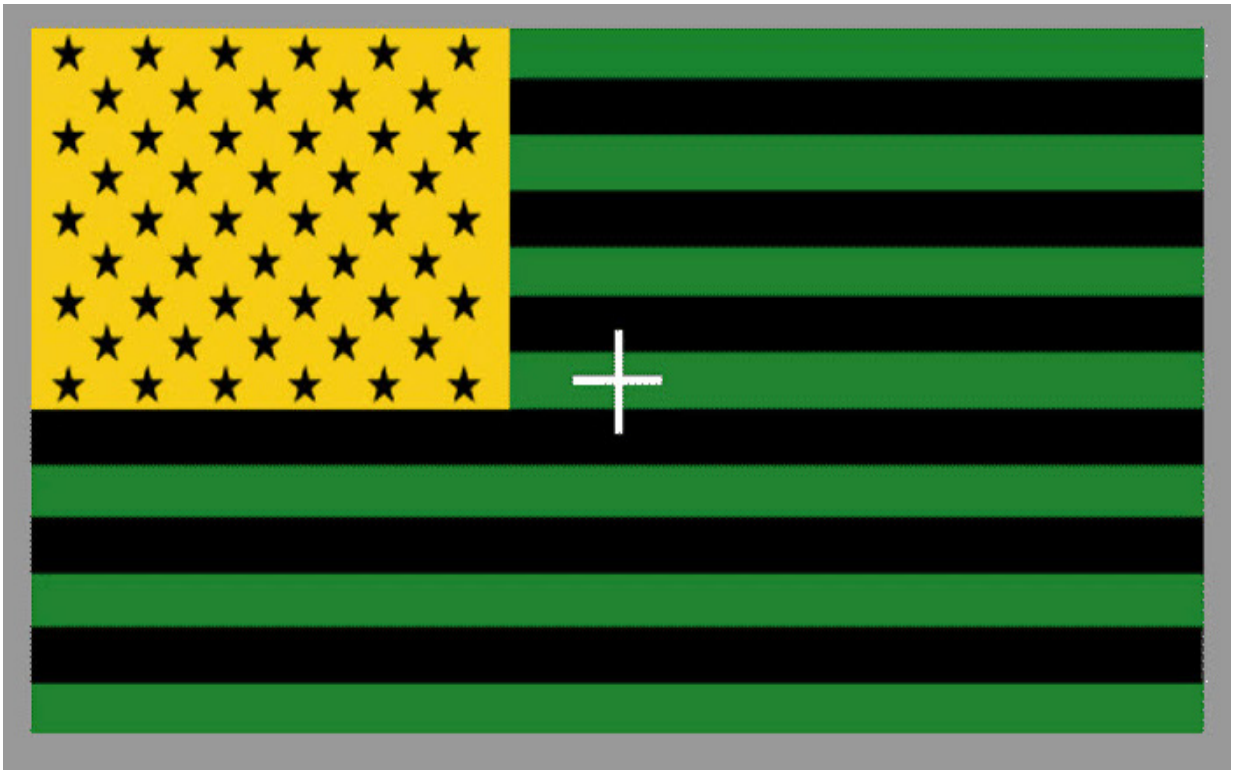


Figure 3.1 Stare at the cross in the middle of the image for 30 seconds, then look away and onto a white surface.

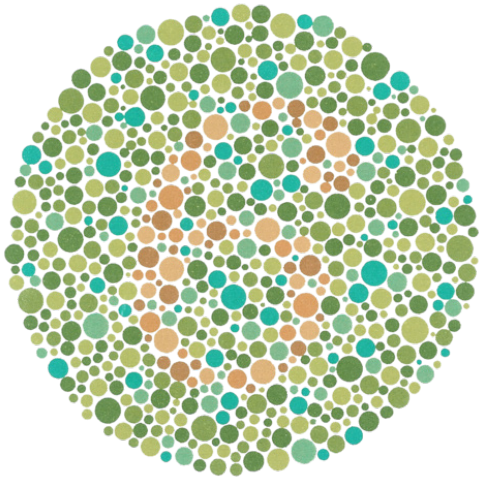
3.1.2 Print Description

Each print in *Double Blind Test Series* consists of a circular image, or section of a circle, centred in its upper three quarters. This large circle comprises 600 to 700 smaller circles of various size and hue. The hues were sampled from the Ishihara plates and variations in value created and introduced to the prints to add visual interest. Two of the prints, *Buddha Accordion* and *Tongue Star and Gold Tooth*, incorporate additional colours relating to blue/yellow colour blindness. All of the small circles in the prints were overlaid by texts from William Blake, Aldous Huxley and Tom Wolfe to provide additional visual texture and observations on perception.

Enlarged Braille numerals were also visually and tactilely embedded in the imagery of the prints. One print contains a Braille numeral visible only to the colour-blind,

foretelling later directions of the project's development.

Each print's title was selected from phrases encapsulated in chosen circles of the print's layout, in homage to both the cut-up method text poems of Allen Ginsberg and to randomisation in the double-blind test protocols alluded to in the series title.



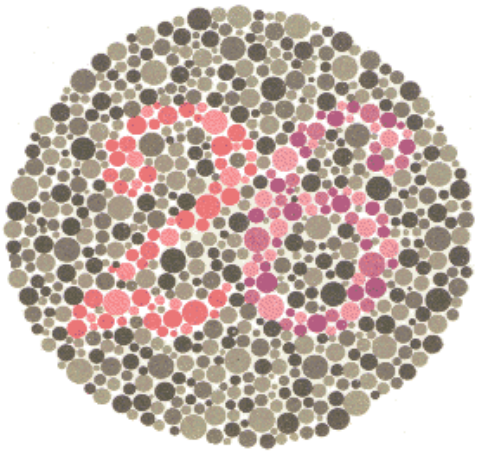


Figure 3.2 (top) Those unaffected by red-green CVD will see a 6 in the image.

Figure 3.3 (bottom) The typically sighted will see 26 in the image. Those with protanopia will see 2 and those with deuteranopia will see 6.

3.1.3 Ishihara Test

The Ishihara Test is used to determine red-green CVD, commonly referred to as colour blindness. First published in 1917, the test was designed by Dr. Shinobu Ishihara of the University of Tokyo (Ishihara 1917). The full test consists of 38 coloured plates each containing various sized circles or dots of colour arranged as a larger circle.[1] Although the dots seem random, most plates contain Roman numerals that are camouflaged to certain viewers. Those with normal colour vision see certain numbers. Those same numerals are invisible, hard to see or different to those seen with red-green CVD.

Some numbers and patterns of the *Ishihara Test* are hidden from the colour blind, while others are hidden to those with typical sight. In Plate 11 the numeral 6 is perceptible to those with typical colour sight but hidden from those with red-green colour vision deficiency (CVD), commonly referred to colour blindness (Figure 3.2). Numbers are also obscured for the typically sighted, with those with CVD seeing different numbers in some of the plates. From the instructions for the *Ishihara Test* I learned that, for example, Plate 22 reads as 26 with normal vision, 6 with one type of colour blindness and as 2 with another type of colour blindness (Figure 3.3). Important in redirecting my work, this complimented the idea that the visible messages found in Braille are

illegible to most of those that can see them. Braille combined with imagery inspired by the *Ishihara Test* provided a framework for exploring these themes through print making methods and materials.

3.2 APPROACHING THE WORK

While not wanting to just mimic the Ishihara test, I did want to keep aspects of its imagery in the hope this guided viewers to expect variations in the prints targeting different visual abilities. To that end, I retained many aspects of its layouts, motifs and colours.

Whereas the Ishihara test segments viewers into various populations based on their visual abilities, the intent of this work was to be inclusive by incorporating elements aimed at different visual acuities, including those with typical sight, myopia (near-sightedness), hyperopia (far-sightedness), CVD and blindness. Some aspects can be seen only by close examination while others appreciated from a distance. Braille and other embossings are incorporated, spot varnishes were used as was text set in widely varying point sizes. One print used colour to create imagery only viewable by those with CVD.

3.2.1 Print Size

Aiming for the largest prints possible, print size was limited by standard paper sizes, the size of printing press beds and digital printer dimensions, and what was manageable in the required multi-step process.

3.2.2 Colour Palette

The colour palette was derived from the Ishihara plates, with additional visual interest created from varying some of the hues and values found in the original *Test* plates. New

Figure 3.4 All of the 38 plates of the Ishihara Test.

hues were added to differentiate rare blue/yellow colour blindness.

In the 38 plate *Ishihara Test*, and as seen in Figure 3.4, the different combinations of colours are as follows:

- Two plates utilise combinations of blue-grey dots contrasted with orange dots
- Thirteen are dominated by various green hues containing numbers created by various red-orange hues.
- Ten have red-oranges as the dominant colour and a numeral created by green dots.
- Six plates use grey tones as the dominant colour, with each containing one numeral or line created out of red dots and one numeral or line made of violet dots.
- Seven plates are made up of fairly equal amounts of dots of oranges, greens and browns.

For five of the prints in the Series, I used the Apple Macintosh utility *Digital Colour Meter* to sample colours from the Ishihara Test plates. I sampled both the oranges and the greens from the orange-dominated digital photograph of Plate 6, recorded their RGB values, and later converted them to CMYK. Beginning with those colours and not being constrained by diagnostic outcomes, I concentrated on tonal relationships. I varied value, saturation and hue of the sampled colours to generate the eight different oranges and six different greens that became the colour palette for *Working Spontaneously Would Be Rash*. Two additional green variations completed the colour scheme used in *Beyond Mere More, By and By, Approaching Reasons Unknown,* and *Day-Glo Precognition.*

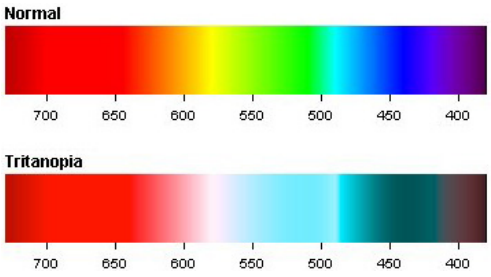


Figure 3.5 Colours for Buddha Accordion and Tongue Star and Gold Tooth were identified by choosing different greens, yellows and blues from the normal spectrum which appeared similar in the tritanopia spectrum.

The first and last prints of the series, *Oddity Is Not the Pattern* and *Hanging Teeth Sizzle*, use value variations on colours sampled from the grey and orange of the first plate in the Ishihara test.

Two of the prints (*Buddha Accordion* and *Tongue Star and Gold Tooth*) incorporate colours relating to blue/yellow colour blindness, which is not tested for in the Ishihara plates. These colours were identified from colour spectrum illustrations for blue-yellow colour blindness, sampled and their values varied to create visual interest. (Figure 3.5)

The only colour of *Cannot Fatten Word* is the grey tone created by a circle of dense text.

Light reflected from a circle of clear varnish text over the white paper, and shadows created by embossed Braille are the only colour or tonal variation in *Concrete Imaginings*.

3.2.3 Dots

With minimal variation, for both the circular field backgrounds and the numerals, the *Ishihara Test* plates tend to employ four dot sizes in fairly equal proportions, each approximately fifty percent smaller in area than the next. To increase the contrast between the background and numerals in my prints, I used three dot sizes for the background and four slightly larger dots for numerals. Two prints, *Cannot Fatten Words* and *Concrete Imagining*, have no coloured dots.

3.2.4 Template

In Adobe Illustrator on an 84 x 112 cm page, I drew a circle, approximately 66 cm in diameter. Within this circle I drew in a 50 cm Braille cell rotated at 13° to emulate the italic

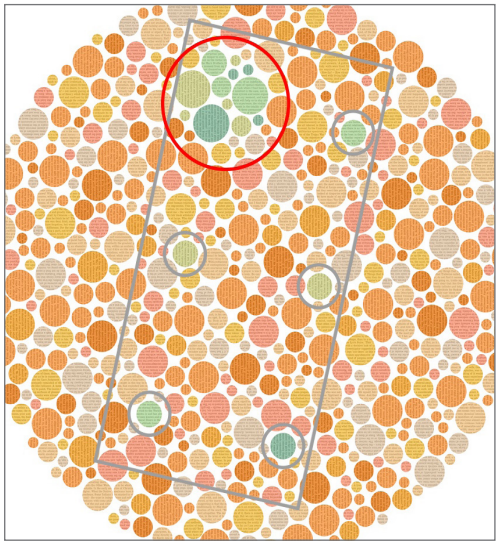


Figure 3.6 For a number one, the upper left of the Braille cell is activated

look of the *Ishihara* numerals. The circle was centred in the upper portion of that page. Centred at 95 cm from the bottom was a textbox for the Braille title's layout. This became the template for development of the series imagery.

3.2.5 Methodical Randomness

In the *Ishihara Test* both the use of colour within each dot and the placement of the different sizes within each plate appears random. I wanted to emulate that random look. To do so required a methodical approach.

I began randomly filling in the circle of the template with the three sizes of dots I had developed for the background. Then using the four sizes of dots I had developed for the numerals, I filled in an area that represented the activated area of the Braille cell for the number 1, the upper left dot of the cell. To indicate that it was a Braille cell represented, I indicated the non-activated cell areas with small dots in the other five areas of the Braille cell (Figure 3.6).

When all areas were filled I evaluated the overall effect, adjusting any unintended groupings, patterns and relationships between individual dots or relationship between the Braille cell and the rest of the image.[2]

I then introduced the colours – the eight oranges as the background colour, and the six greens into the Braille cell, adding colour to one dot and then moving to another at the opposite side of the composition, changing colours after every ten dots or so. Again, adjustments were required after all the dots were given colour to create the look of randomness.

3.2.6 Text as Texture

The individual dots of the original illustrations for the *Ishihara Test* were created using watercolour paints (Kindel 2005). I initially tried to recreated the look of the watercolour by adding various textures to my dots in Photoshop. This worked but seemed to mimic the original plates rather than be inspired by them. The solution was to use text as texture. I used actual text to substitute brush stroke, creating a visual texture that also allowed exploration of layered meanings. Encouraged by the wordplay, I sought texts that related to the developing theme of perception. After some research into texts on perception, I chose the entirety of William Blake's *The Marriage of Heaven and Hell,* selections from Aldous Huxley's *Doors of Perception/Heaven and Hell*, and Thomas Wolfe's *The Electric Kool Aid Acid Test.*

The two books by Huxley chronicle his experiments with mescaline and the insights he gained through its use. William Blake's *Marriage of Heaven and Hell* is where Huxley finds the titles to his two books and I postulate, a kinship into the understanding of the self. The final book is Tom Wolfe's *The Electric Kool-Aid Acid Test* in which Wolfe chronicles Ken Kesey and the Merry Pranksters' personal and collective revelations through the use of LSD. Wolfe makes multiple references to Huxley and 'doors of perception'.

By stripping the texts of their formatting and laying them out in multiple chapter length blocks, I was able to transform them from comprehensible stories into visual texture (and integrate my ongoing theme of hidden messages). This allowed the texts to operate as texture rather than organized written expression.

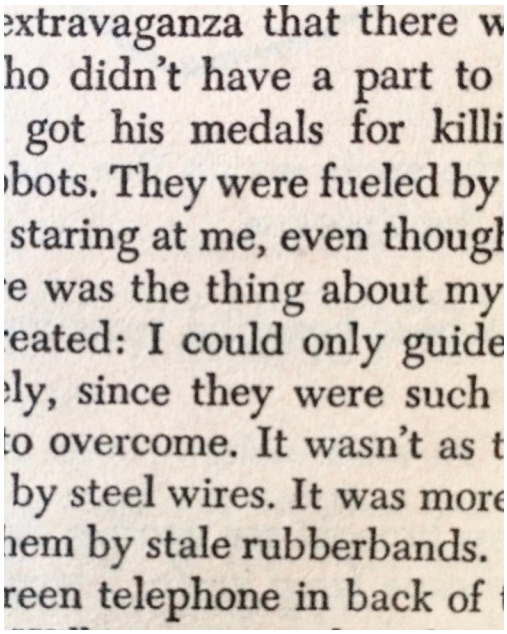


Figure 3.7 Section of a page from the 1973 Dell Paperback edition of Breakfast of Champions by Kurt Vonnegut, Jr.

Figure 3.8 Text that fell inside a dot was cut to fit that dot.

The text blocks were sized the same as the large circular imagery of the prints. The length of the texts and desired textural effects helped determine their density in the prints and the point sizes used in their typesetting. The 5,000 words of the *Marriage of Heaven and Hell* were set as a 66 cm x 66 cm block of text in 9-point type. The 135,000 words of *The Electric Kool-Aid Acid Test* were set into 27 different 48 cm x 48 cm blocks of 9-point text, each containing approximately 5,000 words, dependant on chapter breaks. All of the text was set in *Old Newspaper Type*, to emulate the typographical look of 1970's paperbacks (Figure 3.7).

The text was laid over the dots in the prints. Text falling inside a dot was cut to fit that dot and then printed over the top of the dot to serve as its texture. Some prints used a single block of text, others used multiple blocks of text rotated at predetermined intervals and falling on predetermined dots (Figure 3.8).

3.2.7 Creating the Titles

The titles for the prints in the *Double-Blind Test Series* were generated through use of a variation on the cut-up technique employed by artists and writers such as Allen Ginsberg, William Burroughs and Brion Gyson. With Ginsburg figuring strongly in Wolfe's *The Electric Koolaid Acid Test*, employing a related technique tightened the conceptual tie between the source text and its visual expression in my work. It also provided additional means by which hidden meanings are revealed.

The texts contained in each dot were discrete groupings in which I searched for interesting word combinations. I set parameters: all the words of the title had to

Figure 3.9 An early iteration of Buddha Accordion. 'Buddha' and 'accordion' can be found in the centred blue circle.

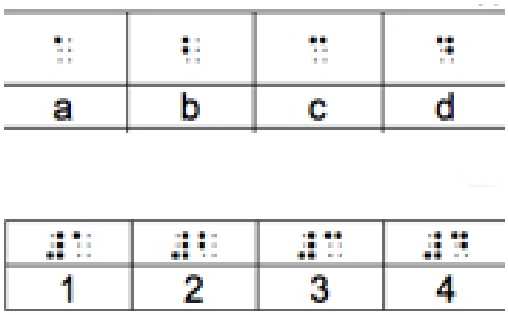


Figure 3.10 *1* through *9* and *0* Braille second cell dot configurations are the same as the Braille cells for a through j.

Figure 3.11 Originally, Double Blind Test Series was to be hung in the same pattern as Bell Telephone's touchtone number pad.

fall within a single circle; they had to be in a logical reading sequence - left to right and top to bottom; no words could be added or changed. If I found more than one interesting grouping in a print, I chose the one that best suited the piece (Figure 3.9). These became the titles to the works. The titles were translated into Braille and embossed into the bottom quarter of each print.

3.2.8 Numbering the Prints

Braille Numbers

The double-blind test series replaces the numbers found in the *Ishihara Test* with numbers rendered in Braille. Each of the 12 prints in the series contains a Braille cell for one of the Arabic numerals for 0 – 9, or for the # or * symbol. Because of the limited possible variations of dots within a Braille cell, the numbers 1 through 9 and 0 use the same cell configuration as the corresponding first letters of the alphabet (Figure 3.10).

1 uses the same Braille cell layout as *A*. The upper left hand dot is raised. To differentiate numbers from letters, Braille uses the # before a number or series of numbers. The first print of *Double Blind Test Series* uses a Braille # to identify the following Braille characters as numbers. The last print in the series uses the Braille representation of the star symbol, *, echoing the number pad layout used in touchtone telephones.

Touchtone Influences

Originally, the prints were to be presented and hung in the same pattern as Bell Telephone's touchtone number pad, reflecting the communication function of the prints and with the intent that the recognizable and familiar three by four layout would suggest the numbers contained in the prints (Figure 3.11).

The layout of the numbers for the touchtone phone was thoroughly researched by Bell Laboratories to produce the most intuitive approach to dialling a phone. (Deininger 1960). They are arranged three across and 4 down. In the top row the numbers across are left to right 1, 2, and 3. The second row has 4, 5 and 6 and the third row 7, 8 and 9. The fourth row has the star sign on the left, a 0 in the middle and the number sign on the right.

Initially, *Double Blind Test Series* prints were to be done on a quarter sheet of paper rather than the approximately full sheet they became. At this size, the prints were too large to be exhibited in the Bell touchtone grid pad layout.

But the touchtone pad had a continuing influence on the print series. The initial series of ten prints containing the Braille numbers 1 through 9, followed by 0, was bracketed with one print containing the Braille symbol for '#' and another with the Braille '*', echoing the inclusion of those two symbols in the touchtone pad. As the first print in the series, Oddity Is Not the Pattern contains a large Braille # in the middle of the print, denoting to Braille readers, at least, that what follows are numbers.

The Prints' Corresponding Numbers
The resultant series is:

- #⠼ Oddity Is Not the Pattern
- 1⠁ Working Spontaneously Would Be Rash
- 2⠃ Beyond Mere More
- 3⠉ Tongue Star and Gold Tooth
- 4⠙ Buddha Accordion
- 5⠑ By And By
- 6⠋ Anonymous Play
- 7⠛ Cannot Fatten Words
- 8⠓ Concrete Imaging
- 9⠊ Approaching Reasons Unknown
- 0⠚ Day-Glo Precognition
- *⠔ Hanging Teeth Sizzle

3.2.9. Image Development
3.2.9.1. Concept to Production
Progressing from conceptualizing to printing necessitated moving away from my original restricted and rigid ideas and plans, into something practical for production, which was less prescriptive and ultimately more visually interesting.

Visual Concept
The original concept was very specific. The series was to be based on the Ishihara colour-blind test. Each print was to resemble the others through the overall size and the size of the circular imagery in the centre. All of the smaller circles that made up

the larger circle were to be similar with comparable variation between them. Some circles, representing Braille numerals, were to be raised through embossing. The colour schemes were to be variations based on the ***Ishihara*** colours. Each print was to contain text sourced from Blake, Huxley or Wolfe, stripped of its formatting and used as visual texture on the smaller circles. A line of Braille text generated by the random interaction of the circles and text was to be placed at the bottom third of each print.

Tests
For *Double Blind Test Series*, as with the prints from *Graphic Design For the Blind*, I experimented with materials and techniques, identifying which would be optimal for production.

To conduct the media tests before finalizing the layouts in Illustrator, I created a smaller version of one print, moving from 84 x 112 cm to 40 x 50 cm. I tested three papers, Epson Professional single weight paper, Somerset Velvet 255 g and Rives BFK for ease of use, and embossed using laser cut 3 and 6 mm hardboard sheets as embossing plates.

Inkjet Printing
Inkjet printing was selected to accommodate the variety of hues and tones within the planned colour palette. Ink-jet inks were put to the test, with prints produced on a HP T790 using Design Jet inks and the Epson 9800 with Ultra Chrome K3 inks. The latter produced superior prints with denser colours truer to the original files.

Screen Printing
Screen printed varnishes were used to vary the print surfaces. Once I had determined the ink-jet printing and paper I tested screen-printed varnished for the text. Slightly tinted TW Clear Gloss Base double screen-printed through a T140 mesh gave the desired results.

Embossing
Using a Clydesdale press, the Somerset and Rives both embossed well, with the 6 mm hardboard producing substantially deeper embossments. But using rolls of Somerset on the Epson 9800 proved easier and more precise than hand-feeding sheets of BFK through the printer.

3.2.9.2 Initial Production
Thinking I had perfected my approaches and materials, production began with the ink jet printing of two copies of the finalised images for *Working Spontaneously Would Be Rash* and *Beyond Mere Mor*e. They were then screen printed with translucent text.

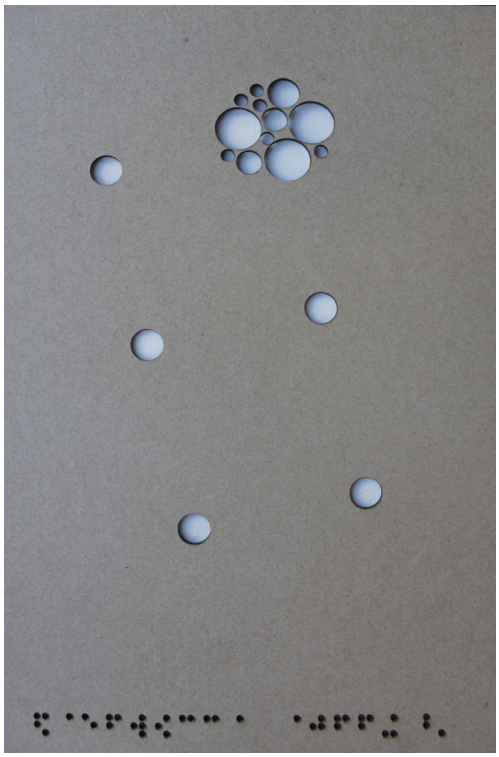


Figure 3.12. Hardboard was laser-cut and used as the embossing plate.

Paper Stretching

The corresponding full size 6 cm hardboard embossing plates were laser cut (Figure 3.12).

The prints were then embossed using a Clydesdale press. Getting the right pressure to produce deep embossing without tearing the paper was the first challenge. To set the pressure, scrap pieces of the Somerset paper were used. Getting deep embossments resulted in torn paper. Pulling back the pressure a bit and inserting a 2.5 cm thick sheet of foam rubber between the paper and the blanket worked, generating the desired deep embossments without tearing the paper.

After determining the correct settings, one of the full-sized ink jet/screen prints was embossed. The pressure required to give a strong embossing stretched the paper considerably, throwing the registration off by over 1 cm towards the bottom of the print. In the original test, there had been some stretching of the paper but I made the mistake of not scaling up that distortion for a print over four times the area.

Paper Soaking

While I was pondering the problem after printing and stretching the first two, the third was soaking. After 15 minutes, I took out the third print to emboss and found that the inks had started to float off the paper. I went back and inspected the two embossed prints and found that some of the inks had come off onto the tissue paper I used to protect the Somerset paper from the hardboard plates. Also, the intensity of the colours was significantly reduced. The bleeding was solved by spray misting the back of the paper before embossing. The small amount of water facilitated the paper

Figure 3.13. Detail from *Anonymous Play*.

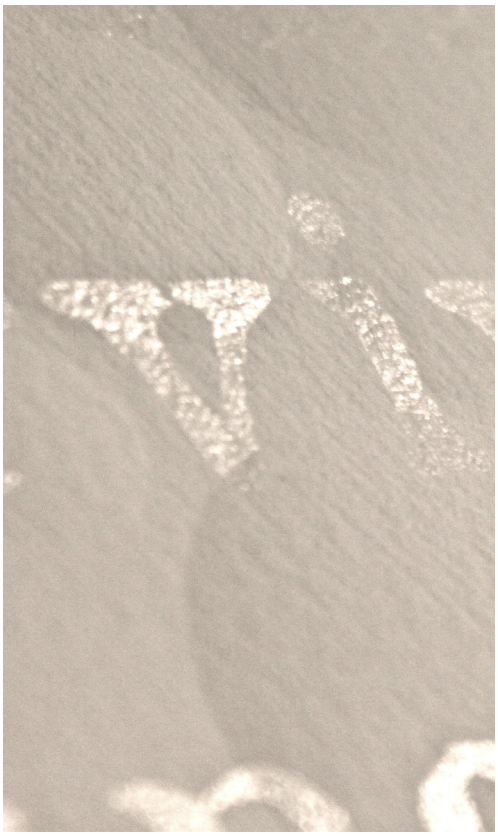


Figure 3.14. Detail from Concrete Imagining.

to stretch without ripping and since the image itself was not wet, it did not bleed.

3.2.9.3 Reconsideration

Although the dissolving ink problem was solved, the registration problem required me to rethink aspects of my imagery. Much of the hoped-for impact of my original print concept were tactile aspects created by the embossing of various coloured circles. But, the mis-registration defeated the effect and made the prints look badly crafted.

Because of an approaching exhibition date I had to quickly resolve the various issues. First I had to let go of my rigid conception of the look of the series.

Instead of the imagery alone driving the development of the prints, printing processes were considered concurrently with the revisions of the imagery. Precise alignments of embossed and printed areas were eliminated or changed so that general relationships between printed and embossed areas were created. Large embossed circles contained several printed circles as in *Anonymous Play* (Figure 3.13). Or the embossed areas were independent of printed imagery, serving as an enigmatic layer of content exemplified by *Concrete Imagining* (Figure 3.14).

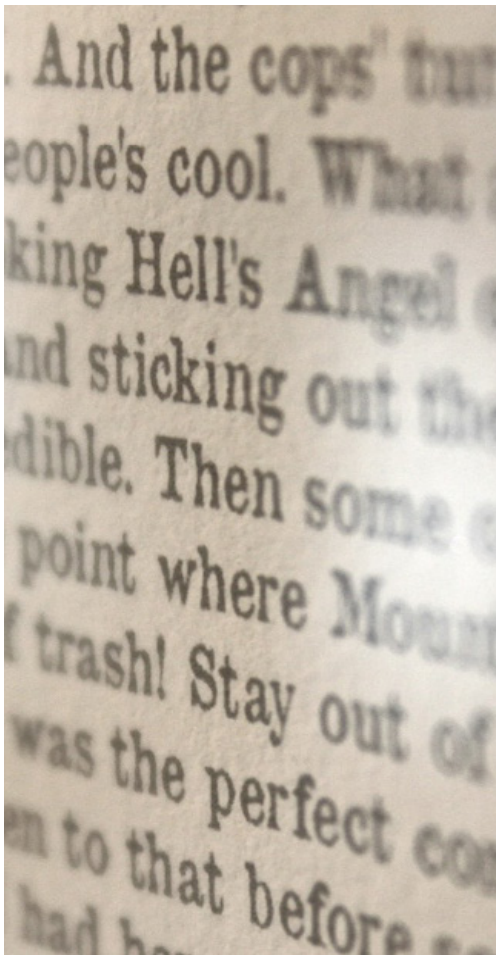
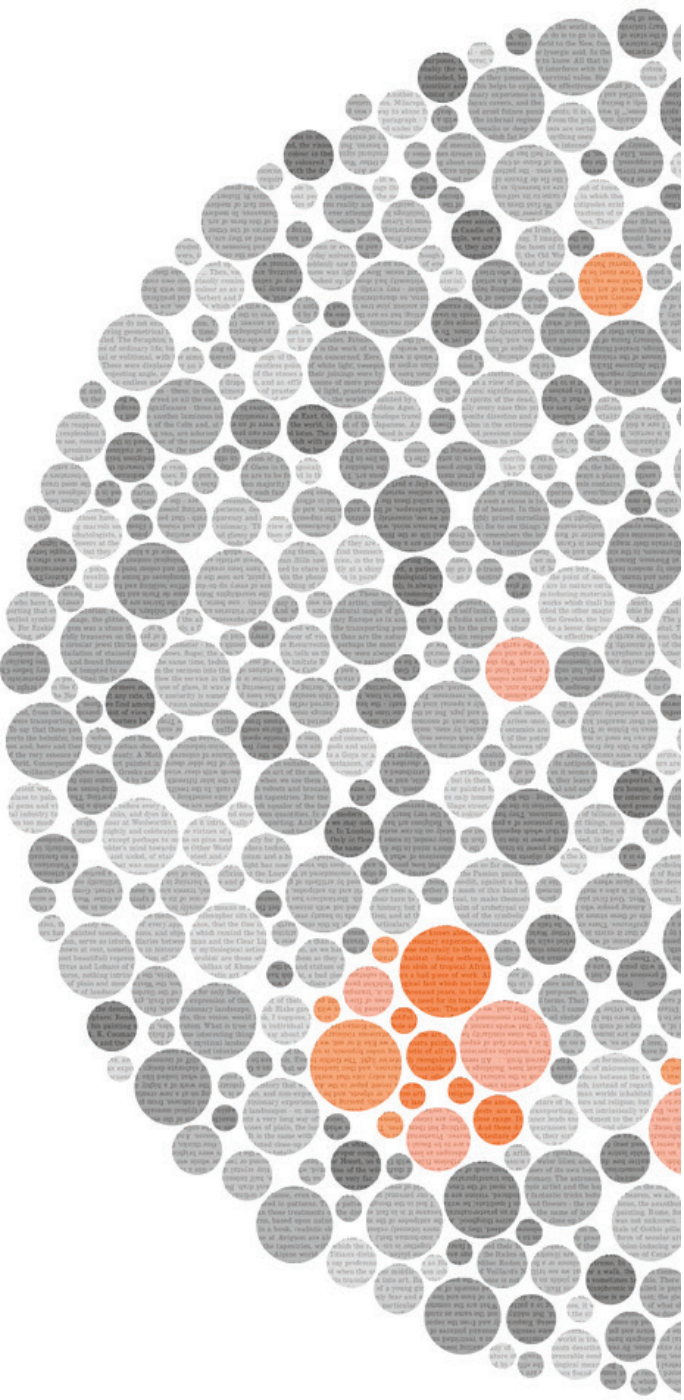


Figure 3.15 Except for text, imagery was removed in some of the prints.

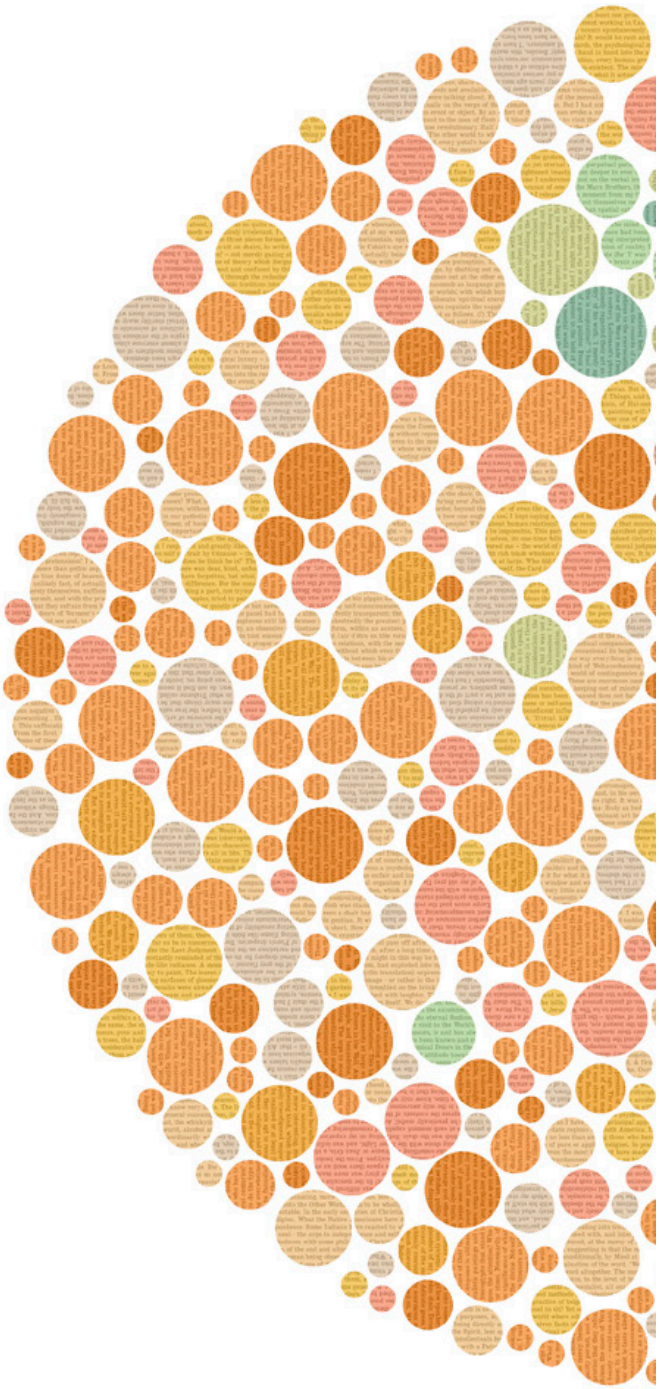
Breaking free of the original plan with of precise registration of embossings and printed circles also allowed me the freedom to break the prescriptive framework I had created for the imagery itself. Rather than the centred radial balance of the original prints, the later ones explored cropped imagery and asymmetrical compositions. In others, the imagery itself was almost entirely eliminated (Figure 3.15).



3.3 ODDITY IS NOT THE PATTERN

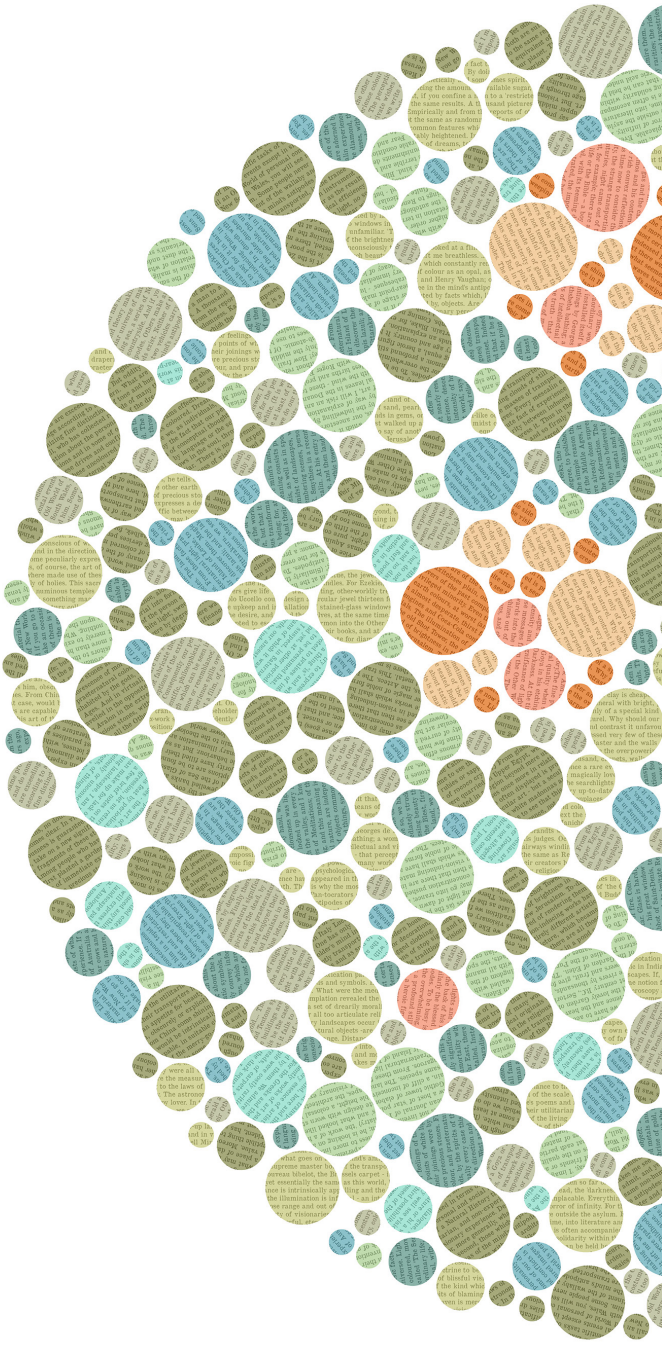
Oddity is Not the Pattern is the first print in the study of *Double Blind Test Series*. The top three quarters of the print comprise a circle made of smaller dots in grey tones in which an oversized Braille cell of orange tones denoting the hashtag (#) is embedded. The colour scheme was sampled from the grey and orange of the first plate in the Ishihara test, with visual interest increased through the addition of three grey tones and four orange tints chosen for their graphic impact. The intended effect of the colour application is that those with typical colour vision and those with red-green CVD will see the visual Braille representation of #.

Samples of text from *The Marriage of Heaven and Hell* by William Blake were used to give visual texture to the dots. Sections of those texts were screened over the inkjet printed colour imagery. Its title in Braille is embossed and centred in the lower quarter of the print.



3.4 WORKING SPONTANEOUSLY WOULD BE RASH

Working Spontaneously Would Be Rash comprises a large green Braille numeral 1 made of dots in four green hues and four sizes, in the middle of a circle of dots in three sizes and three orange hues which occupies the top three quarters of the print. The screen-printed samples of text were taken from *The Marriage of Heaven and Hell* by William Blake and rotated according to colour at 90° increments, giving visual texture to the dots. The print's title is embossed in Braille in the lower quarter. The intended effect of the colour use is that those with typical colour vision will see the visual Braille representation of the number 1 but that this will remain camouflaged to those with red-green CVD.



3.5 BEYOND MERE MORE

Beyond Mere More repeats many aspects established in its predecessors. It is an 84 x 112 cm embossed, ink-jet screen print. The colour palette is based on colours sampled from Plate 2 of the Ishihara Test. The dots in the circular background field were created using eight green variations of the sampled colours. Six orange variations were used to visually represent the Braille numeral 2. The green and orange dots share four different sizes. The intent of the colour use is that the Braille representation for 2 is visible to those with typical sight, but obscured to those with red-green CVD. The text from Huxley's *Doors of Perception* is sampled from 12 different blocks of text, overlaid at 30° rotational intervals (Figure 3.16). The bottom third of the contains the embossed Braille title, selected from the groupings of words created by the dots.

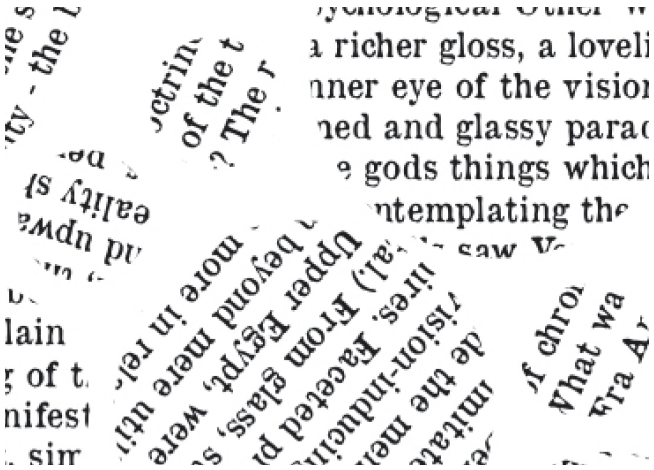


Figure 3.16 Blocks of text overlaid at 30° rotational intervals.

3.6 TONGUE STAR AND A GOLD TOOTH

Tongue Star and a Gold Tooth is the first print of the study to be developed that does not rely on colour sampled from the *Ishihara Test*. It does repeat other aspects established in the first three prints. The colour palette was developed as an imagining of what an Ishihara test plate might look like if it tested for blue-yellow CVD (which the Ishihara Test does not). The circular background field is created from dots of four green variations and four reds. Light shades of blues and yellows are sporadically distributed throughout. Two blue hues and one yellow hue are used to visually represent the Braille numeral three. Wolfe's *The Electric Kool-Aid Acid Test* is sampled by the text and rotated at 90° intervals in concentric circular bands, screen printed onto the coloured dots. The bottom quarter of the print contains the embossed Braille title.

3.6.1 Colour Palette Variation

Looking for diversity in the colour palettes for the prints in the series, I embarked on creating a palette that could theoretically be used in the detection of blue-yellow CVD. My intention was not to develop an actual test for blue-yellow CVD, but to understand how it might be structured and to then express that understanding through colour. Blue-yellow CVD is very rare (National Eye Institute 2017). Because of that infrequency, I did not intend to test my outcomes with tritanopians (the medical term for those with blue-yellow CVD), but I did want to use colours in a way that would show understanding of the condition.

3.6.2 Blue-Yellow CVD

The Ishihara Test diagnoses the red-green CVD, the most common colour blindness.

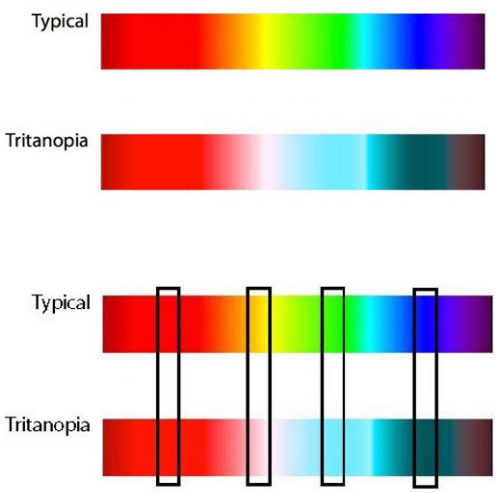


Figure 3.17 Tritanopians see yellows as light violets and greens as blues.

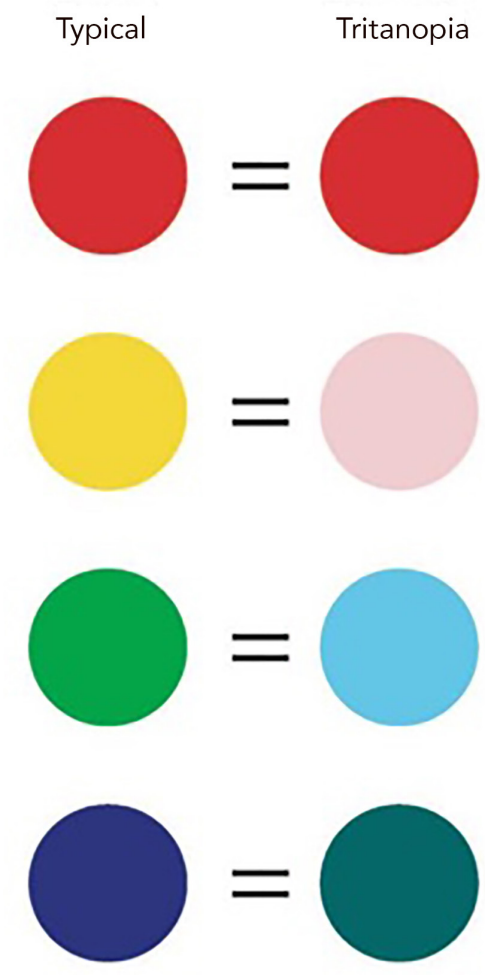


Figure 3.18 Those with typical sight see yellow and green, those with tritanopia see light violet and blue in their place.

Tongue Star and a Gold Tooth is my imagining of what a test for blue-yellow CVD might look like.

Described in more detail in Section 4.1.3, CVD is caused by the absence or abnormality of one or more of the three types of colour receptors in the eye, which are called cones. While there is considerable overlap in colour detection between the different types of cone, short wavelength cones perceive colours at the blue end of the spectrum, medium cones detect colours in the green area, and long wavelength cones detect colours at the red end of the spectrum. Blue-yellow CVD affects the short wavelength cones of the eye (Sharpe, Stockman, Jägle and Nathans 1999). People with red-green colour CVD mistake the colours red and green. In blue-yellow CVD (tritanopia), people confuse blue with green, and yellow with violet. So the term blue-green colour blindness would be more accurate because the colours blue and yellow are usually not confused. (Colblindor 2013)

3.6.3 Development of the Colour Palette

Looking at the typical and tritanopia colour spectrums, we can see that yellows are perceived as light violets and greens are perceived as blues (Figure 3.17). So, while those with typical sight might see yellow and green, those with tritanopia would see light violet and blue in their place (Figure 3.18).

For this, my first attempt working with colours that might not be perceived by someone with tritanopia, I used a similar approach as is used in Ishihara's vanishing number plates. In those plates only individuals with typical vision see a number. In *Tongue Star and a Gold Tooth,* the intent was for a visual Braille representation of the number three to

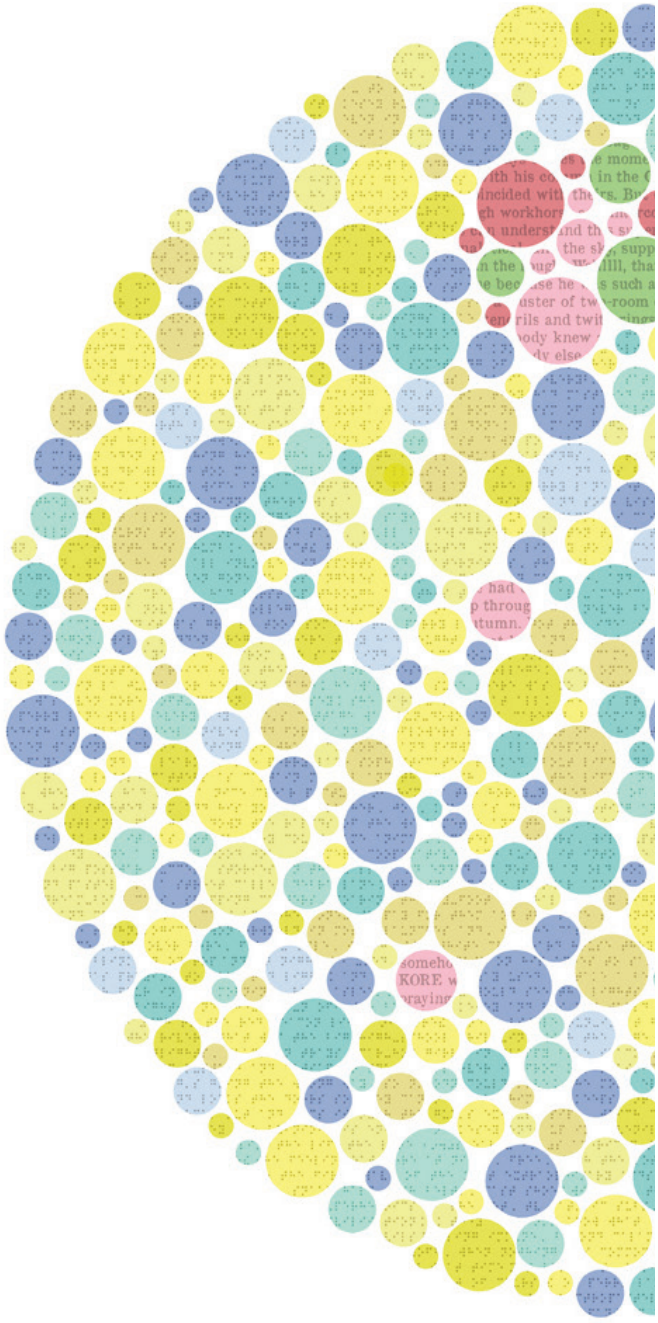
be visible to people with typical vision and those with red-green CVD. For a numeral 3, the upper right and left sections of the Braille cell would be filled, To those with blue-yellow CVD, no number would be visible in the print.

I chose four warm colours, red through light violet and four green variations. I then chose two blues, one a fairly saturated blue, the other a lighter blue-green. I also selected a saturated yellow.

3.6.4 Application of the Colours
The reds and greens were placed and adjusted to appear random with a small amount of blues and yellow scattered throughout, then the dots of the activated Braille cell areas were filled with the yellow and blue hues.

I was satisfied by the visual aesthetics. The overall composition is similar to the other two developed prints, but appears unique due to the unexpected colour scheme.

While it was not tested for diagnostic effectiveness by those with tritanopia, the use of colour and its perception became more important as the print series developed into pivotal later works.



3.7 BUDDHA ACCORDION

Buddha Accordion is the second print created as a facsimile test for blue-yellow CVD. Taking its cue from the red-green CVD test plates from the *Ishihara Test*, and to create visual interest through variation, the background and the Braille numeral colours are reversed for this print. The blues and yellows become colours of the background dots, while red and green dots make up the Braille numeral 4.

3.7.1 Braille Text

Buddha Accordion is the first study to use a purely visual Braille text, its use being inspired by the idea of decorative Braille and the works of artists Chen Young and Anton Parsons (described in Section 2.6.1). The Braille in this print, excepting the title, has no intended tactile presence. It is to be experienced purely visually. Sections of text from *The Electric Kool-Aid Acid Test* were stripped of their formatting, laid out in large blocks and typeset in a Truetype font named Braille. This font uses black dots as visual representations of each letter in place of the corresponding raised dots. The Braille dots themselves are not embossed but visually represented as black dots. This Braille was used in the blue and yellow dots of the print. This approach succeeds in further hiding the text's message and origin while increasing the visual texture. The print's title, as in all of the prints in the series, is embossed in Braille in the lower third of the composition.

3.7.2 Non-Braille Text

The text in the green and violet dots remains typeset in *Old Newsprint* giving clues to the use and meaning of the visual Braille.

3.8 ANONYMOUS PLAY

In *Anonymous Play*, a large number 6 visible only to those with red-green CVD sits in the middle of a circle made of varying blue, yellow, green, grey, red, violet and brown dots which occupies the top three quarters of the print. Printed over the circle in a transparent grey varnish, is a selection from *The Electric Kool-Aid Acid Test.* The print's title is embossed in Braille in the lower third.

3.8.1 Camouflaged Information

Anonymous Play attempts to hide information from those with typical sight while leaving it visible to those with CVD.

The insight gained from imaging and researching what a person with blue-yellow CVD might see, and production of the corresponding prints *Tongue Star and a Gold Tooth* and *Buddha Accordion,* led to the development of this print. It does what Ishihara did in some of his test plates; hiding visual information from those with typical sight while being visible to those with red-green CVD.

3.8.1.1 Ishihara's Targeted Approach to Colour Use

Because of the initial explorations in understanding how those with colour vision deficiencies perceive colour, I became interested in Ishihara's inclusion of numbers in his test that are only visible to those with red-green CVD. In Ishihara's plates such as No. 4, typically sighted subjects read "29" and those with red-green deficiencies "70". Ishihara made his test in five different plate designs (Colblindor 2013):

1) Control: Individuals with typical sight and those with CVD see the same number or pattern.

2) Transformative: Individuals with typical

vision see a different number than those with red-green CVD.
3) Vanishing: Only individuals with typical vision see a number.
4) Hidden: Only those with red-green CVD see a number.
5) Diagnostic: These plates are intended to diagnose between protanopia and deuteranopia types of red-green CVD (see chapter 4.1.3 for a further description of protanopia and deuteranopia).

According to the instructional pamphlet included in the Ishihara test, information is hidden or transformed from those with typical sight. That means those with typical colour vision are having a different perceptual experience than those with CVD, and that difference is intentional:
No. 2. Normal subjects will read “8” and those with red-green deficiencies “3”.
No. 3. Normal subjects will read “5” and those with red-green deficiencies “2”.
No. 4. Normal subjects will read “29” and those with red-green deficiencies “70”.
No. 5. Normal subjects will read “74” and those with red-green deficiencies “21”.
And, even more intriguing:
No. 9. Normal subjects can hardly read it, but most of those with red-green deficiencies see the figure “2” in it (Figure 3.19).

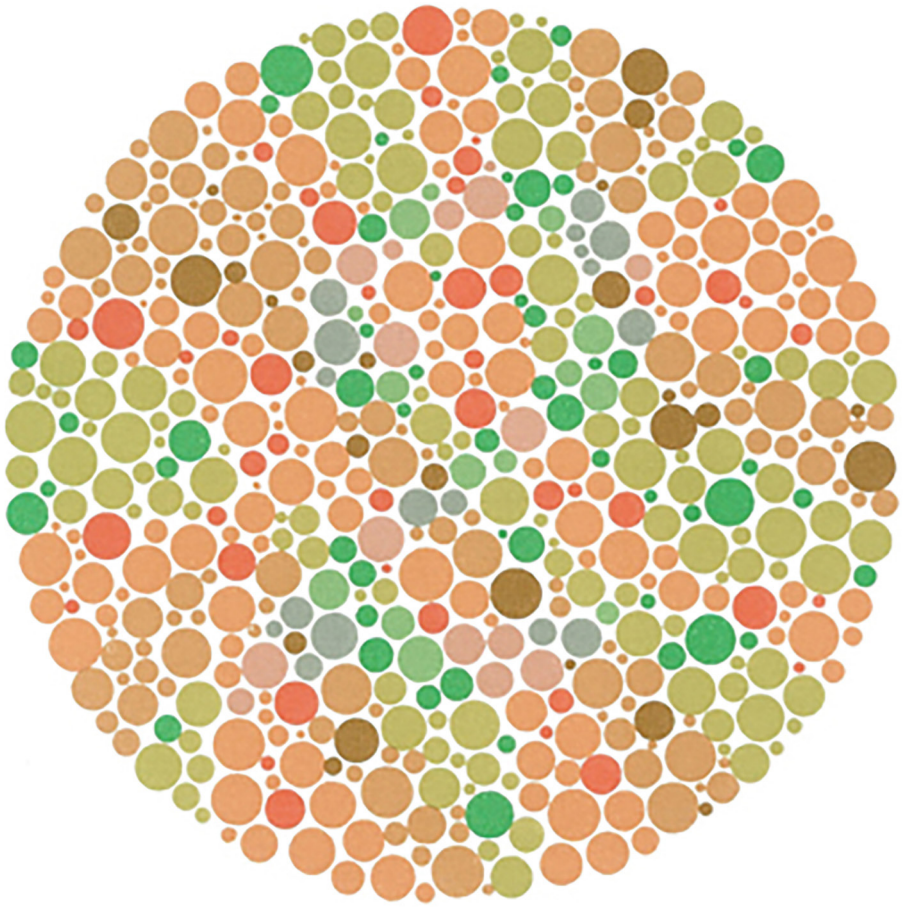


Figure 3.19 Most of those with red-green deficiencies see the figure “2”.

3.8.1.2 The Phenomena Explained

The instructional pamphlet gives a brief explanation of the mechanics of this phenomenon:

> Consequently, one of the peculiarities of red-green deficiencies is that blue and yellow colors appear to be remarkably clear compared with red and green colors. The application of this peculiarity to the test for color vision deficiencies is the distinguishing feature of this series.

3.8.2 First Test Subject

As I developed the work and began sharing it, individuals with colour vision deficiencies presented themselves to me out of interest in the work. One, a colleague, described interesting features about his colour perception, including that he had difficulty differentiating between white and cyan, which I found fascinating. He became the test subject for my first experiments in hiding information for those with CVD.

3.8.3 Hiding the Number

Anonymous Play was created as an interesting variation on a theme to round out a group of prints and, at the time, not as the main line of investigation. In *Anonymous Play*, I did not yet fully understand the physiology of colour perception for those with red-green CVD or how to effectively manipulate colour to reach that audience. Because of that, and not quite grasping the significance of the task at hand, I relied on my colleague down the hall as the CVD reference point. I strove to create a print would hide a number that he could see but others with typical colour sight could not. Using his descriptions of colour perception, I systematically applied them to the dots within the print to create a number 6. I knew from our discussions that blues and yellows stood out for him, and that reds and greens shifted to browns. I also knew that he perceived purples and magentas as blues. After several iterations, I was able to have the number 6 somewhat visible to him while remaining hidden to myself and others with typical colour sight.

3.8.4 First, But Not Last

Being satisfied with my results, at this time my investigations into colour variations influencing visual perception ended. It was not until the exhibition of the prints and the reactions received on this particular print that I realized I had stumbled onto something interesting to an enthusiastic audience. It would later drive my continuing research and reshape my own perspective on perception.

3.9 BY AND BY

By and By, the eighth print in the study, returns to the red-orange and green colour palette developed for *Working Spontaneously Would be Rash*. This is reminiscent the Ishihara Test, where the colour palettes variate and then repeat later in the series. Red-orange dots create the background circle, with a large Braille 7 composed of green dots designed to be visible to those with typical sight and hidden to those with red-green CVD. Samples of text taken from Wolfe's *The Electric Kool-Aid Acid Test* overlay the dots and give visual texture and depth to the dots. The point size of the text varies from dot to dot. The print's title, sampled from the text, is embossed near the bottom in Braille.

The composition attempts to create a sense of visual depth through the manipulation of text point size and placement within the composition. In the dots near the centre of the dominant orange areas I used a large point size and as I moved out towards the outer edges of the orange circle I progressively reduced the point size of some of the dots. I did this in the hopes of creating the illusion that some of the dots were closer and the smaller point size dots were further away. I wanted the green areas of the composition, the dots that made up the visual Braille number six (the upper right and left and the centre left of the Braille cell), to look like they were floating in space closest to the viewer. To achieve this, I made the point size of the text on the green dots larger than in the adjoining areas of orange dots.

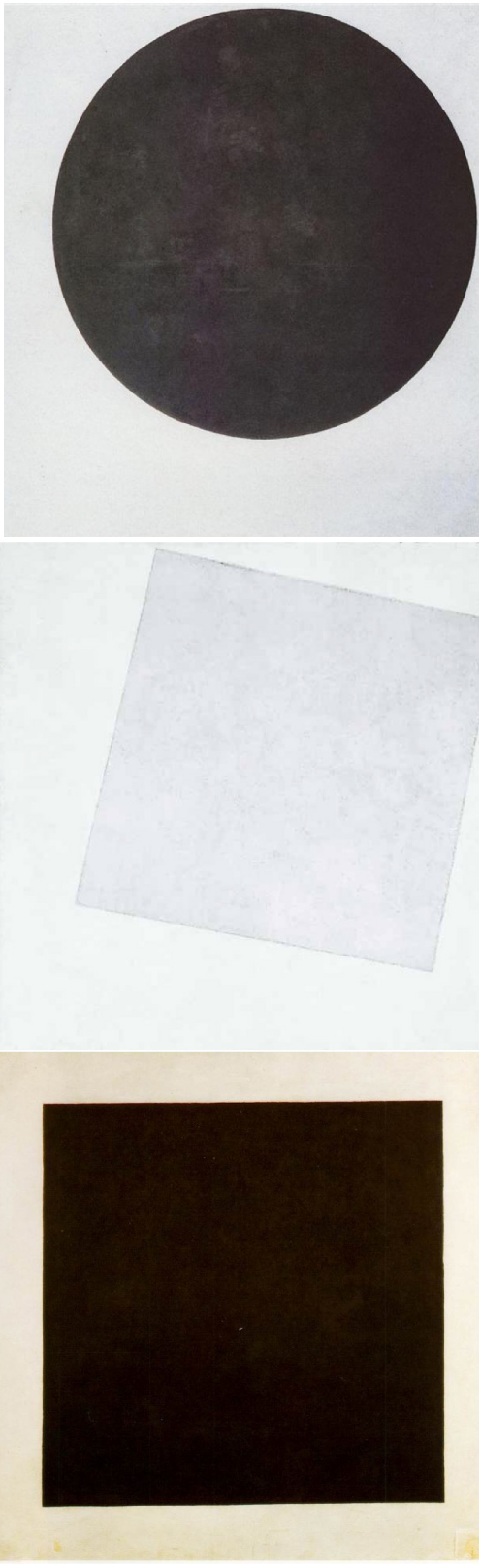


Figure 3.19 Kazimir Malevich, Black Circle, 1915 (top), White on White, 1918 (middle) and Black Square, 1915 (bottom).

3.10 CANNOT FATTEN WORDS and CONCRETE IMAGINING

A large grey circle composed of fine black text dominates the upper two-thirds of *Cannot Fatten Words* (detail, previous page, left). A Braille 7 is embossed in its centre and its Braille title is embossed near the bottom.

Concrete Imagining is white (detail, previous page, right). A large circle of text taken form *The Electric Kool-Aid Acid Test* is screen printed in clear varnish in the upper three quarters. A Braille 8 is embossed in the centre and its Braille title is embossed near the bottom.

Initially, *Cannot Fatten Words* and *Concrete Imagining* were conceived as ironic visual metaphors to push the initial irony of the series; colour vision tests done in Braille. These were colour vision tests stripped of colour. But as the prints developed, and in the context of the texts used for texture in the series, they became much more serious reflections on art, transcendence, religion and perception.

3.10.1 Suprematism

Visually, *Cannot Fatten Words* and *Concrete Imagining* pay homage to Kazimir Malevich, the early 20th century Russian painter, and the Suprematist movement he founded. Both of these are directly influenced by two of Malevich's most philosophically advanced works, 1915's *Black Circle* and *Black Square*, and 1918's *White on White* (Figure 3.19).

Malevich, through the reduction of shape, form and colour to their bare essentials, hopes to reveal the "artistic expression of the existence of man in this universe." (Petrova 2012, 30%) "Malevich excluded all

narrative from his compositions," and monumentalizes the images he has minimized to pure forms (Petrova 2012, 35%).

3.10.2 Imagery as Transcendence
The reduced imagery used by Malevich was transcendental. In it, particularly Black Square, Malevich finds God. "This is the form of a new living organism... It is not a painting, it is something else... the black square is the image of God as the essence of His perfection on a new path..." (Petrova 2012, 35%).

In these two prints the colour is stripped out and the multiple coloured dots are reduced to a large circle of text. The colours and dots are removed, leaving only a large light grey circle in *Cannot Fatten Words,* and a subtle, slightly glossy white circle of text in *Concrete Imaging*. These prints keep the circular form in direct reference to the Ishihara inspired imagery of the prints that come before and after in the series. Also, although Malevich finds ultimate spiritual significance in the square, the circle has spiritual significance in many other mythical, spiritual and religious and expressions.

3.10.3 The Circle
Psychology: The circle is a powerful symbol with a spiritual function. Carl Jung saw the circle as a primordial image and used the circle as the symbol of the Self, the totality of our being. "As a symbol, the circle expresses the totality of our being" (Jung 1978, p. 120).

Religion: In Buddhism, the circle represents the Dharma Wheel or "wheel of reality." The enso, the Zen calligraphic circle, is a symbol of 'enlightenment, power and the universe itself." In the Bible, Ezekiel 1:16 talks of wheels in the sky, symbolizing providence. Proverbs 8:27 describes heaven as "circle on the face of the deep". The circular halo in Christian iconography represents the light of divine grace.

As time: The circle as time was inherited form Sumerian mythology. The Sumerians divided the circle into 360 degrees, which represented the 360 days of the year, with five additional holy days outside of the calendar and outside of time (Campbell 1988).

3.10.4 Text and Perception
The relationship of the text to the developing theme of perception is explored in *Cannot Fatten Words* and *Concrete Imagining*. The previous prints hid the origins of the text by revealing only small sections printed over the various dots that comprise the imagery. Here, much of Chapters 12, 13 and 14 of *The Electric Kool-Aid Acid Test* is presented as a large dense circle of text. From afar it appears as a solid grey circle. Up close, the unformatted text becomes evident. While in the previous prints, the sources of the text had a conceptual relationship to other aspects of the composition, the main function was as visual texture. In *Cannot Fatten Words* the

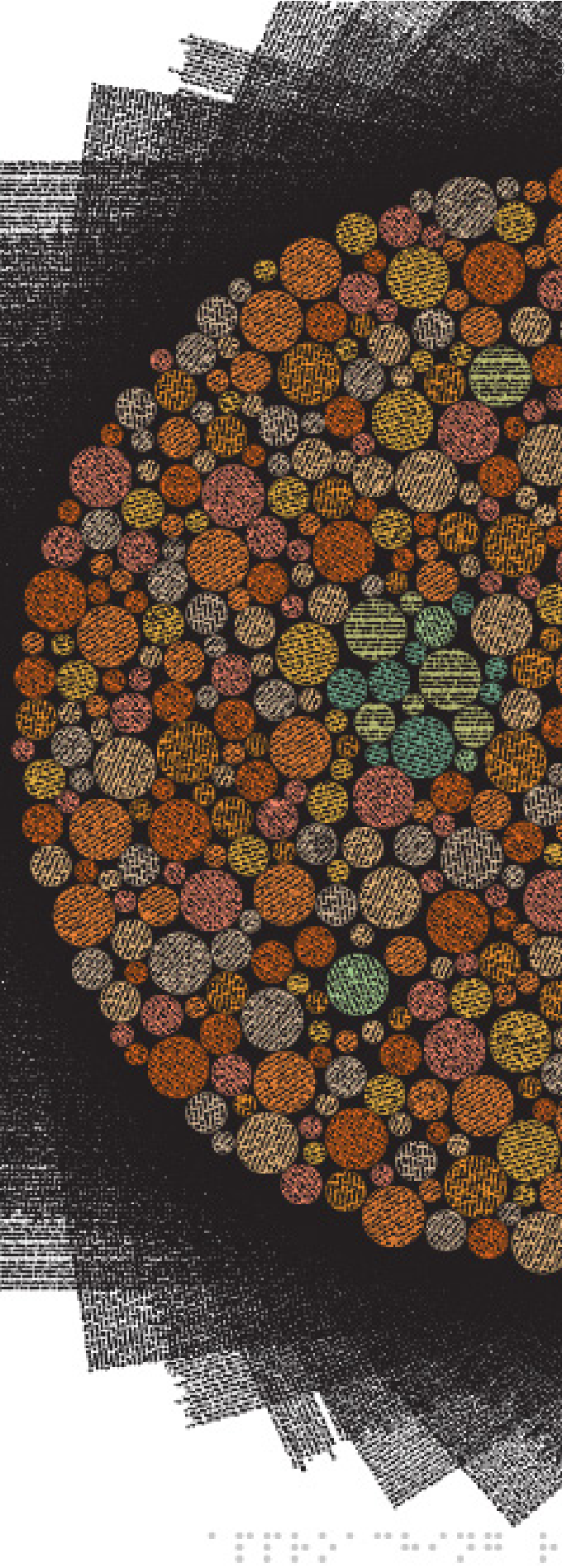
text works as a textured tone at a distance, while up close the text with its stripped formatting becomes evident. The big dense block of text lends itself to reading, not line by line, but by area, with eyes looking for connections between words and phrases within the same area of focus.

The earlier prints established the concept of variations in vision influencing the perception of the work. The inclusion of Braille and the *Ishihara Test* influenced imagery was used to invoke variations in visual perception. Now, through the elimination of all but the circle of text, the emphasis was on other forms of perceptual influence, the themes driving the texts chosen for the series - drugs and religion. The selections from *The Electric Kool-Aid Acid Test* operate as texture, tone and text. By presenting the text as an unformatted mass, an omniscience overview of its entirety is possible as is changing appreciation as one's distance from the print varies. We can view it as a whole, or through moving closer, read individual words and phrases. We can condense the text's linear narrative and move back and forth in its time-line by shifting our eyes from the bottom to the top, or from right to left, to make connections across time in such elements as patterns of punctuation, capital letters, or repeated words.

The text itself, a chronicle of the mind-expanding exploits of Ken Kesey and his Merry Pranksters, and the psychedelic movement with its use of drugs, music, and multimedia experiences, speaks to altered perceptions and higher states of consciousness. From the book:

> I stood close to the band and let the vibrations engulf me. They started in my toes and every inch of me was quivering with them ... they made a journey through my nervous system (I remember picturing myself as one of the charts we had studied in biology which shows the nerve network), traveling each tiny path, finally reaching the top of my head, where they exploded in glorious patterns of color and line… (Wolfe 1966, p. 147)

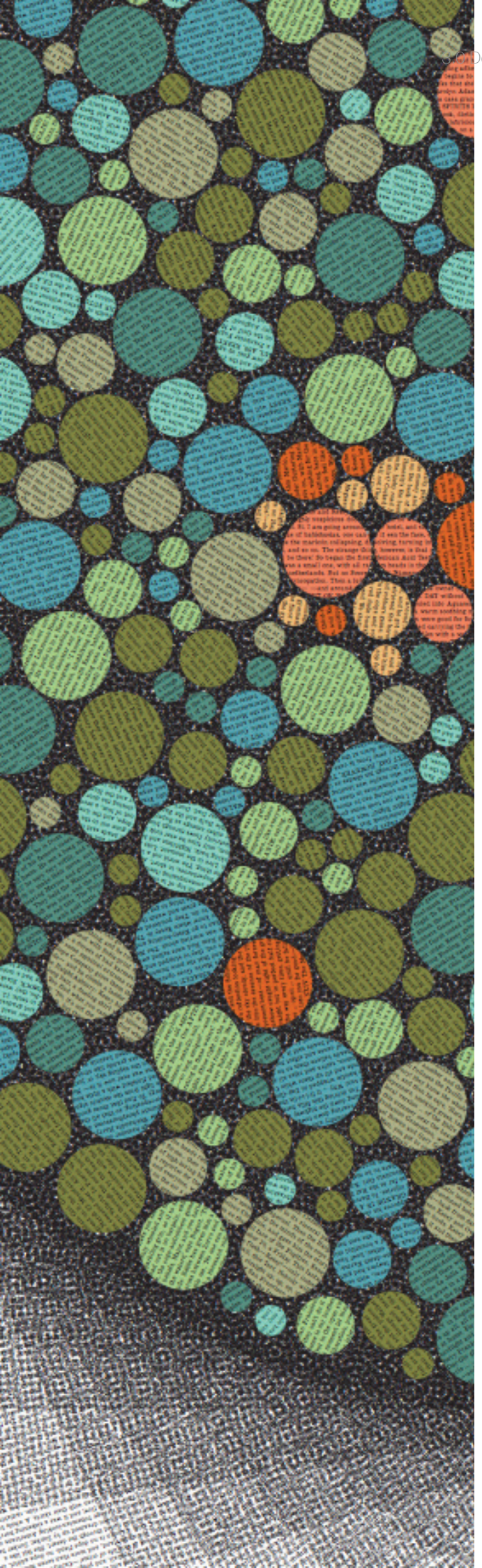
The previous prints established a link between variations of vision influencing the perception of the work. *Cannot Fatten Words* and *Concrete Imagining* make the link to other forms of changing perceptions, drugs and religion.



3.11 APPROACHING REASONS UNKNOWN
A large Braille 8 made of text covered green dots sits in the middle of a circle made of varying text covered red-orange dots which occupies the top three quarters of the print. The background to the dots is a highly textured black. Triangles of overlapping text from *The Electric Kool-aid Acid Test* which radiate out from the large circle, are created from the dots interacting with the edges of the sides and top of the print. A line of Braille, the print's title, is embossed near the bottom. The print uses the text layers that had been masked in the other prints to create a black between the individual circles and the grey tones of the radiating triangles.

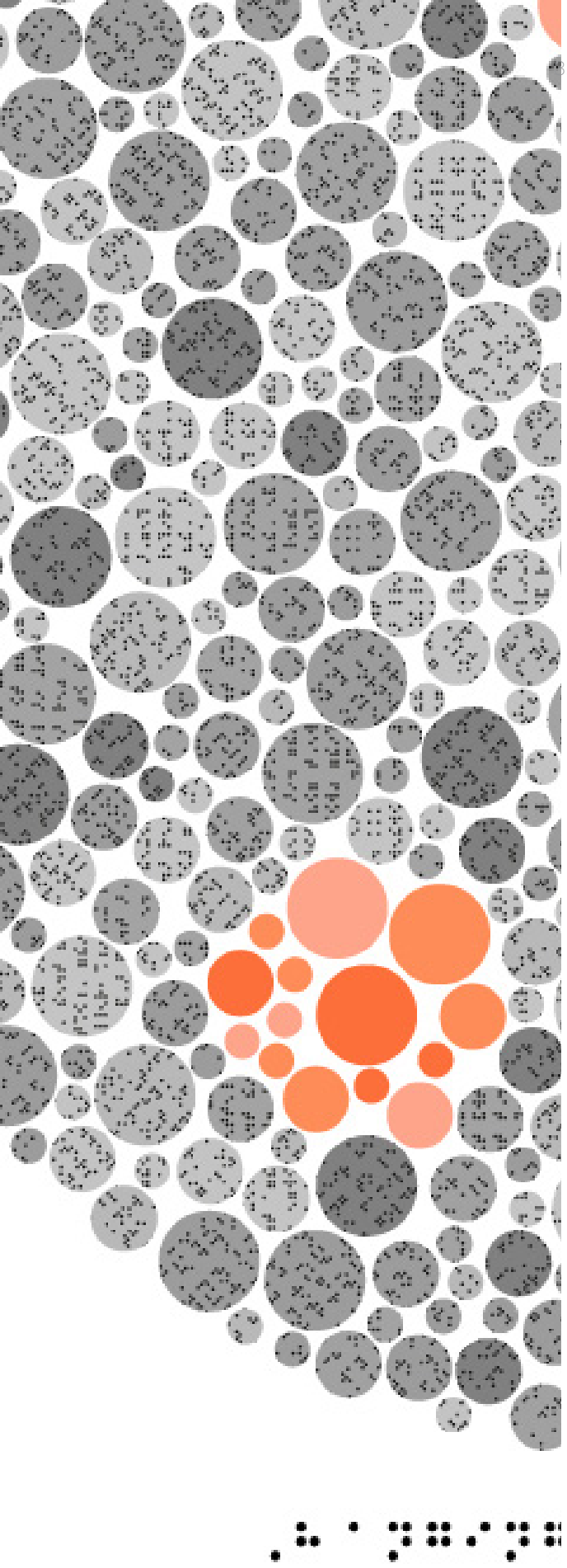
The print reintroduces the red-orange and green colour palette of previous prints and introduces a black background created from the overlapping blocks of text. The look of the print is reminiscent of string art and Spirograph drawings, popular in the 1970's, with their radiating mathematical symmetry.

The overlapping of the radiating text renders much of it illegible, but its presence reveals how the imagery was constructed in many of the previous prints. This composition is more dynamic than the previous prints, with the edges of the picture plane cropping some of the imagery.



3.12 DAY-GLO PRECOGNITION

For the first time in the series, the imagery interacts with all edges of the picture plane. While remaining centred left to right, the large circle of all the previous prints bleeds off the top and sides of the print. The radiating triangles similar to those of *Approaching Reasons Unknown* are cropped by the bottom and lower sides of the paper. The large Braille 9 of text covered red-orange dots sits diagonally in the upper three quarters of the print. The textured black background found between the coloured dots transforms into grey triangles of text as they radiate out from the curved form. The text is from the last chapters of *The Electric Kool-aid Acid Test.* The Braille title is embossed over the grey text near the print's bottom.



3.13 HANGING TEETH SIZZLE

Hanging Teeth Sizzle completes the *Double Blind Test Series*. Against a white background, a large Braille '*' composed of red and orange dots of varying sizes sits diagonally in the upper three quarters of the print, surrounded by grey dots. The colours of the print are brought back to those of the first print - the control colours of *Oddity is Not the Pattern*, intended to be seen by both those with typical sight and those with CVD. The '*' is the only reminder of the relationship that the series has to the Touchtone keypad.

Samples of text taken from *The Marriage of Heaven and Hell* by William Blake and set in Braille give visual texture to the grey dots. The orange dots are text free. An orange dot is cropped by the prints top edge as are grey dots by the print's sides. The title is embossed in Braille near the bottom of the print.

3.14 EXHIBITION

Double Blind Test Series was exhibited at the Hannah Maclure Centre Gallery, Abertay University, Dundee Scotland, 26 July – 11 August 2013. The exhibition consisted of the twelve prints framed and hung in sequence starting with the Braille '#' print, *Oddity Is Not the Pattern* and ending with the Braille '*' print, *Hanging Teeth Sizzle.*

Initial interest in the work was expressed through newspaper articles, TV and radio interviews including *BBC News* coverage, a *BBC Scotland* interview, and coverage on cultural activity websites and blogs. *Printmaking Today* published an article dedicated to the work.

The exhibition was attended by 874 people during its run (as recorded by the HMC Gallery).

The audience offered information about their visual acuities. While no attendees were blind, those with a wide variety of visual acuities attended, including those with severe myopia, hyperopia, macular degeneration, and a large number with CVD were propelled to the exhibit by media coverage of the use of the Ishihara Test imagery.

Through conversation and a survey, audience responses to the work were gauged. Questions were asked about the properties of the work: Were the embossed Braille

areas noticed? Were areas of varnished screen printed text detected? Did the printed text work as visual texture? Was the colour-blind test inspiration obvious? Did you like the titles?
The response to the work was overwhelmingly positive. From the respondents, the work was engaging and enjoyable. The use of the Ishihara inspired imagery was described as “thought provoking”. The Braille embossed in the prints was identified as such, with one respondent having limited vision and not noticing it until responding to the subject on the questionnaire. Text as visual texture was described as flipping between “surface and deep structure.” The text printed in varnish “caught” a respondent “by surprise” creating a “good walk from picture to picture.” The titles were “loved,” “thought provoking,” “baffling, but lovely to say aloud.”

There was also a small formal survey. The quantitative data from those five *Double Blind Test Series Questionnaire* is provided in support to the conversational responses.

From 5 respondents
1.00 =poor, 5.00 =excellent

Question	Response
Did you enjoy the work?	4.80
Were you engaged by the work?	4.80
Was the colour-blind test inspiration obvious?	4.60
Were you able to see the embossments and Braille dots in the prints?	4.00
Did the text in the prints work as visual texture?	4.20
Were you able to see portions of the transparent and translucent text printed on some of the prints?	4.75
Did you like the titles?	5.00

The positive responses to the show were countered by one question asked about the work. It was a question that I had no answer for at the time, but echoed my own concerns. “If you wanted to engage those with limited or no sight, why did you frame them with glass over the prints?”

Later that year, two of the prints from the series, *Working Spontaneously Would Be Rash* and *Beyond Mere More*, were chosen for inclusion in *Impressions*, a juried international print exhibition at the Sarah Silberman Art Gallery, of Rockville College, located near Washington DC.

3.15 PANEL DISCUSSION
During the exhibition, on 10 August, 2013 the panel discussion *Field of Vision*, an examination of the crossover of visual arts research and game design for the disabled, was held in conjunction with the exhibition and as part of the United

Kingdom's biggest independent computer games festival, *Dare Protoplay*.

With myself as the chair, the panel members were:
Tom DeMajo - Creative Director of award winning independent game developer Quartic Llama, the creator of *Other*, a unique "alternate reality sound game". It was the first ever game commissioned by the National Trust of Scotland.

Robert Jackson – Print Studio tutor at Dundee Contemporary Arts and creator of a tool that translates a user's eye movements into a digital image.

Dr. Doug Lester – Lecturer of Genetics, Abertay University involved with identifying the many human chromosomal locations and gene mutations that cause a large group of progressive degenerative disease called Retinitis Pigmentosa .

Dr. Graham Pullin - Course Director of Digital Interaction Design at Duncan of Jordanstone College of Art And Design. His books include *Design Meets Disability*, published by MIT Press.

Dr. David Sloan – an Accessible User Experience Engineer with The Paciello Group, consultants on accessibility for websites and web and mobile applications.

The topics of discussion were guided by themes related to *Double Blind Test Series* and broadened to be inclusive of the panel members' interests and expertise. Subjects included: the cross benefits of engaging audiences of varying abilities; the benefits of constraints within design; understanding causes of disabilities and their relationships to interface solutions; complimentary disciplines as partners in design solutions; technology as the extension of our senses; and the use of sound to engage audiences.

3.16 FINDINGS
Double Blind Test Series transitioned the research from *Graphic Design for The Blind*. It continued the exploration of embossing standard and expressive Braille into all twelve prints. It renews the examination of text with Blake's *The Marriage of Heaven and Hell*, introducing exploration of dualism to the studies, and Huxley's *Doors of Perception* and Wolfe's *The Electric Koolaid Acid Test* emphasis on perception.

Hidden messages and meanings were further embedded with the *Ishihara Test* influenced imagery, leading to the exploration of visual messages targeted to vision specific audiences.

Importantly, *Double Blind Test Series* shifted the line of research from the tactile to the visual, moving the intended audience from the blind to those with varying visual acuities.

The twelve prints point to directions of further investigation. Braille was used as a design element but its full tactile potential was superseded by the visual as the prints developed. The large layouts of text, stripped of their formatting were used in small sections or printed in varnish to give texture and visual interest whilst hiding their literal messages. Additionally their source, the hundreds of thousands of words in 70 cm blocks of text, have a striking visual impact of their own.

The developed blue/yellow CVD test remains untested.

During the exhibition of the print series, one route of study stood out; the use of colour to embed differing messages aimed at those with specific visual colour perceptions. It is this that I explore in the next chapter.

Notes

[1] A plate is a print made from a set of process colour printing plates. There are four process colour plates, one for each of the following colours – cyan, magenta, yellow and black, commonly referred to as CMYK. K is for key. The black plate is the key colour to which the others are aligned, thus the letter K. The original test images were painted using water colours and reproduced using the process colour printing method.

[2] To create variation of dot placement from print to print, the template filled with the dots was rotated, and flipped on both its vertical and horizontal axis. With each print the activated areas Braille cell also changed requiring additional adjustments in dot placement because of the different sizes of the dots used for the Braille cell.

References

Campbell, Joseph. 1988. The Power of Myth with Bill Moyers. New York, Doubleday.

Colblindor. 2017. Available from: http://www.color-blindness.com/ [Accessed 20 May 2017].

Deininger, R. 1960. Human Factors Engineering Studies of the Design and Use of Pushbutton Telephone Sets, *Bell Labs Technical Journal* (Volume 39, Issue 4. July 1960). pp. 995–1012.

Jung, C. 1978. *Man and his Symbols.* Available from: https://monoskop.org/images/9/97/Von_Franz_Luise_Marie_Jung_Gustav_Carl_Man_and_His_Symbols_1988.pdf [Accessed 1 May 2017].

Kindel, E. 2005. Ishihara. *Eye.* Available from: http://www.eyemagazine.com/feature/article/ Ishihara [Accessed 19 January 2017].

National Eye Institute. 2017. Available from: https://nei.nih.gov/ [Accessed 24 May 2017].

Petrova, E. 2012. *Malevich's Suprematism and Religion (Kazimir Malevich: Suprematism)*, Kindle Edition. New York, Guggenheim Museum.

Sharpe, L., Stockman, A., Jagle, H. Knau, H. and Nathans, J. 1999. L, M and L-M Hybrid Cone Photopigments in Man. *The National Center for Biotechnology Information.* Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3121536/ [Accessed: 20 May 2017].

Wolfe, Tom. 1966. *The Electric Kool-Aid Acid Test*, New York Macmillan.

Colour Blind Test

4.0 STUDY THREE: COLOUR BLIND TEST

Colour Blind Test was the first of three works to be done in collaboration with computer scientist Dr. David Flatla, of the University of Dundee. It was driven by the aim of understanding vision's influence on perception and the intention of subverting duality, and conducted with the revised questions: *Can artwork be intentionally created to be experienced differently dependent on one's visual abilities? If so, can those experiences be shared?*

The other two works, *Eye for An Eye* and *Triple Blind* are discussed in the Chapter 5.

4.1 OVERVIEW

4.1.1 The Concept

Colour Blind Test is an exploration of visual stimuli that aims to simultaneously engage audiences of varied colour vision acuities. This concept evolved from *Double Blind Test Series*. The use of the Ishihara inspired imagery in that series drew those with CVD, including David Flatla, to its exhibition. The successful engagement of audiences of differing colour vision abilities helped drive this evolution.

I wanted to refine the techniques I used in *Anonymous Play* from *Double Blind Test Series* to make the number 6 visible only to those with red-green CVD. With Flatla's expertise, digital simulations in real time on computers and tablets were developed to share differing experiences with audiences not typically able to view them.

The Ishihara inspired imagery, successful in effectively indicating the concerns of visual perception, particularly CVD, was continued.

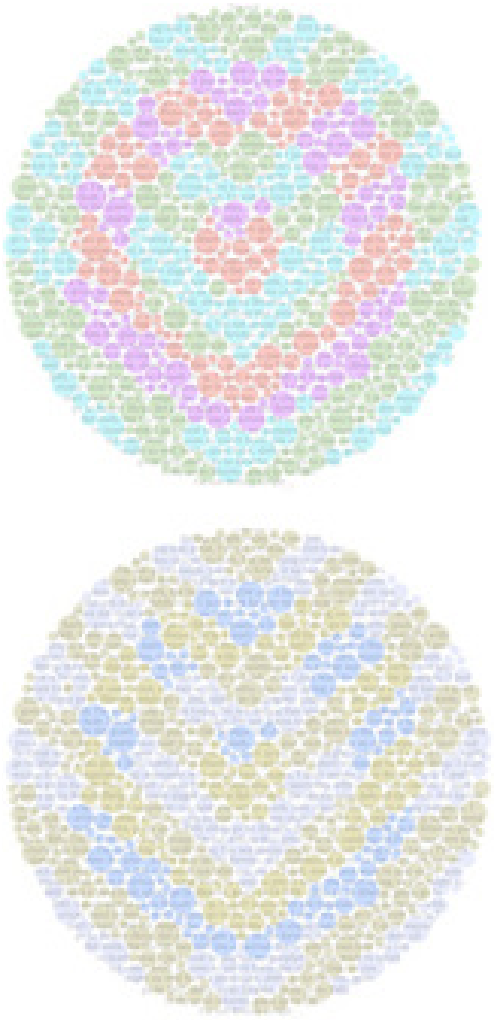


Figure 4.2 *Goats* from *Colour Blind Test.* Original on the top, CVD simulation on the bottom.

With work that could be intentionally be experienced differently, exploring and testing dualism became crucial. Popular dichotomies of right and wrong, up or down, and left and right were challenged. Viewing the work on its own and with the software allowed viewers to dispute those dichotomies. The titles and text within the prints underscored them.

4.1.2 Print Description

The 84 x 112 cm un-editioned prints are divided into two diptychs; *Heaven and Hell* and *Sheep and Goats*. Through colour manipulation, they communicate different details to individuals with colour vision deficiencies (CVD) than to those with typical colour vision (Figure 4.2). Chevrons dominate for those with CVD. A bull's eye dominates for people with typical colour vision.

The prints rely on imagery influenced by the *Ishihara Test* and developed for Double Blind Test Series. The colour palette consists of red, magenta, blue and green tints. They are layered with repeated song lyrics typeset in *Old Newspaper* and screen printed in varnish. The bottom quarter of each print has the print's title typeset in *Old Newspaper.* The paper is Somerset Velvet 255 g, printed with Ultra Chrome K3 inks using an Epson 9800 inkjet printer. TW Clear Gloss Base was double screen-printed through a T140 mesh for the lyrics.

Different versions of the artwork are revealed to the different audiences through the use of computers and tablets fitted with augmented reality CVD simulation and re-colouring software.

4.1.3 The Eye and CVD

An understanding of how humans perceive

colour underpins many of the techniques employed to develop this body of work. CVDs (colour vision deficiencies) affect about eight percent of the male population and half of one percent of the female population (Colour Blind Awareness 2017). CVD is a reduction in the number of colours perceived by an individual, such that colours which are distinct to people with typical colour vision are no longer distinct for people with CVD. For example, pink, grey, and turquoise are distinct colours for most people, but for those with CVD these colours may look the same (Lyons and Flatla 2014).

4.1.3.1 Light Reception in The Human Eye

Human vision is mediated by light passing through the lens and onto the retina where it is detected by a range of photoreceptors. The typical human eye is a 'double vision' organ (Hecht 1937). In bright light it detects colour and in dim light, value, that is light regardless of colour (much like a black and white photograph). Corresondingly, the human eye has two types of photoreceptor cells: cones and rods. Rods detect value (Hecht 1937) and play no role in the pathology of CVD. Cones detect the colour of light and exist in three forms, distinguished by the ranges of light wavelengths to which they optimally respond. Thus, long wavelength cones primarily detect reds, mid wavelength cones primarily detect greens, and short wavelength cones, blues. The three types of cone are customarily named as red, green and blue cones.

The green cones most strongly respond to green light, but their detectable range encompasses red oranges to blue-violets. The detectable range for red cones, reds to blue-violets, is very similar, however, red cones respond to yellow light most strongly. Blue cones respond most effectively to blue-violets, but have a detectable range from violet through blue-greens (Figure 4.3).

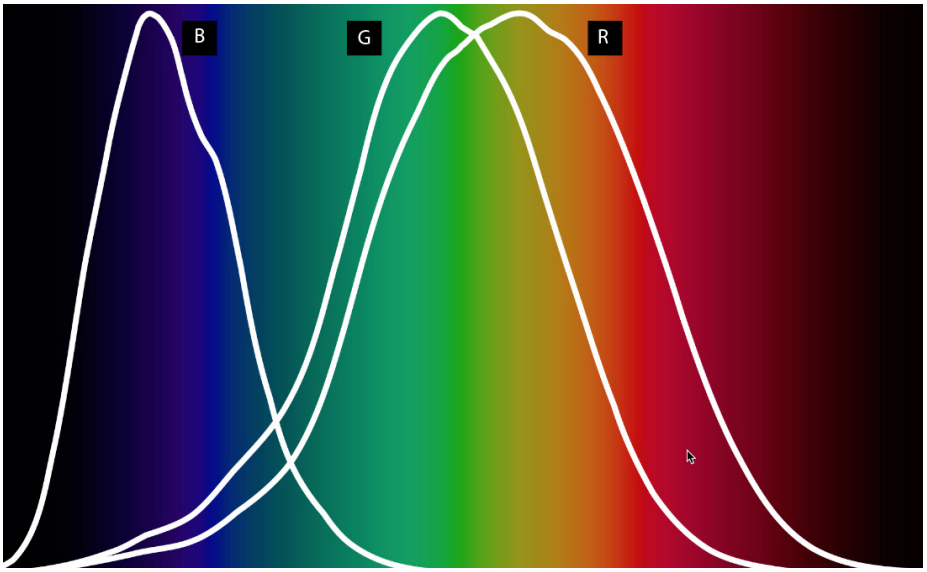


Figure 4.3 Green cones strongly respond to green light, but their detectable range encompasses red oranges to blue-violets (G). The detectable range for red cones, reds to blue-violets, is very similar, however, red cones respond to yellow light most strongly (R). Blue cones respond effectively to blue-violets, but have a detectable range from violet through blue-greens (B).

Cones exist in 2 states: on (active) and off (inactive). When activated by a light wavelength within their range, they transmit a signal to the brain. If they are not activated, no signal is transmitted. Colour experience is calculated by the brain from the pattern of distinct signals received from each of the three types of cone (Hurvich 1981). “Information about colour is indicated by which cells signal and how frequently they do so” (Livingstone p. 26).

When all three types of cone are functioning correctly we perceive the full spectrum of colors shown in Figure 4.3 (Hecht and Selig 1937).

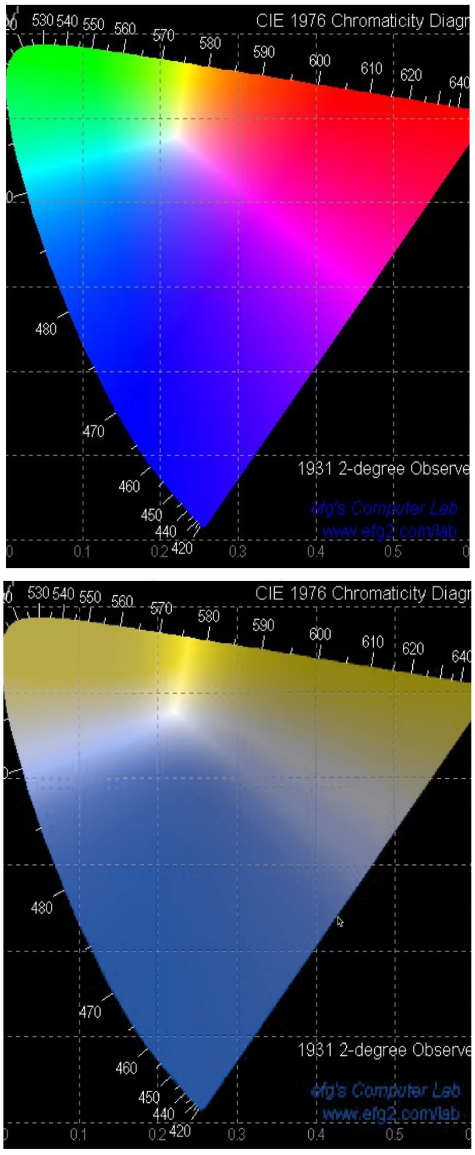


Figure 4.4 CIE colour space model. 2D representation. Figure Y: Deuteranopia simulation of the CIE colour space mode.

4.1.3.2 Understanding Colour Perception in CVD

In CVD, one of the types of cones is missing or impaired. The loss of function impacts colour perception such that the range of visible colours is narrowed. CVD occurs in three main forms – missing or malfunctioning red cones (protanopia/protanomaly, respectively), missing or malfunctioning green cones (deuteranopia/deuteranomaly), or missing or malfunctioning blue cones (tritanopia/tritanomaly).

We can use a colour space model to explain how CVD presents.

4.1.3.3 CIE Color Space Model

The International Commission on Illumination/Commission Internationale de l’Elcairage (CIE) created a model to define the relationship between physical colour and its perception in human physiology.

The CIE Colour Space is a three-dimensional model representing all the colours which can be seen by the human eye (Smith and Guild 1932). It uses the combination of red, green

and blue through their entire tint, tone and shade range and the reaction of the human eye's rods and cones.

The model can also be represented in two dimensions, where it takes the rough form of an inverted triangle with green on the left, red on the right and blue on the bottom. White is towards the middle (Figure 4.4).

4.1.3.4 CVD and the CIE Colour Space Model

The upper image in Figure 4.4 represents the colour space visible to a human with complete photoreceptor function. The lower image represents the colour space as seen by those with deuteranopia, a common type of red-green CVD. To the typically sighted almost all colours we see are made up of varying proportions of red, green and blue, as represented by the relative proportions of activated red, green and blue cones with variations of lightness or darkness sometimes thought of as black (shade), white(tint) and gray (tone) partially detected by rods.

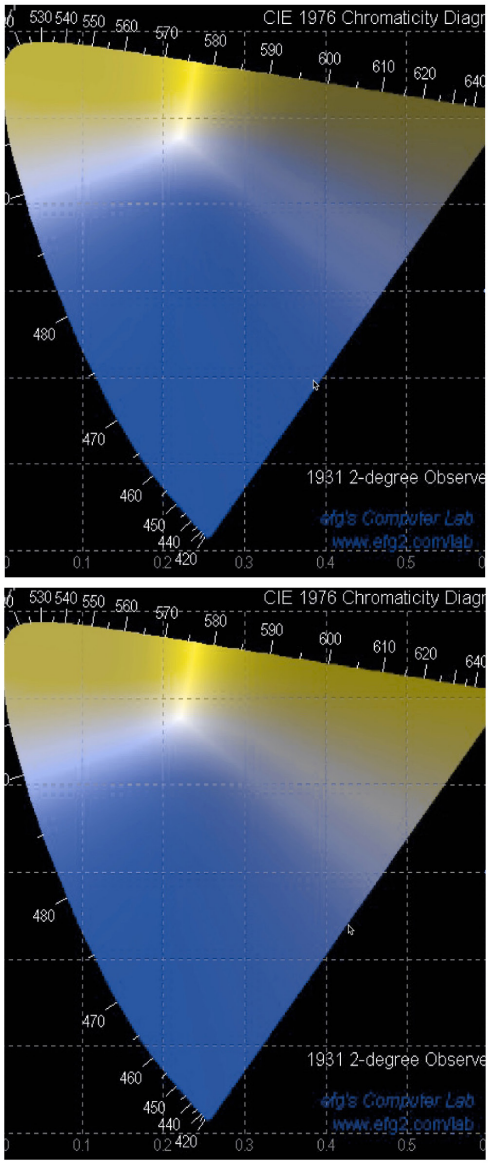


Figure 4.5 Protanopia simulation of the CEI colour space on the top, deuteranopia on the bottom. Greens and reds appear as yellow-browns.

Red-Green CVD

In red/green CVD, the red or green cones do not function typically, and reds and greens are not perceived distinctly. What is perceived comprises the remaining colours and tints, tones and shades. The CIE Colour Model, as seen in Figure 4.5 is modified for an individual missing red cones, protanopia CVD on the top; and green cones, deuteranopia CVD on the bottom.

Because blue, green and red cones typically detect specific ranges of light wavelengths, if one of them is missing as in tritanopia, protanopia and deuteranopia, the resulting absence of colour perception can be plotted within the CIE color space. In the case of

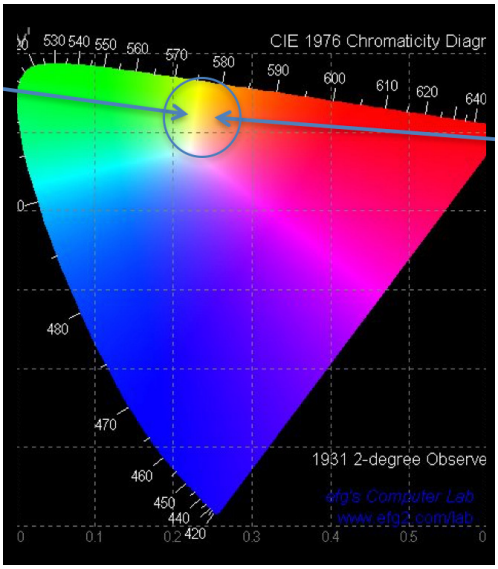


Figure 4.6 All the colours on the red-green axis appear as yellow-brown to someone with red-green CVD.

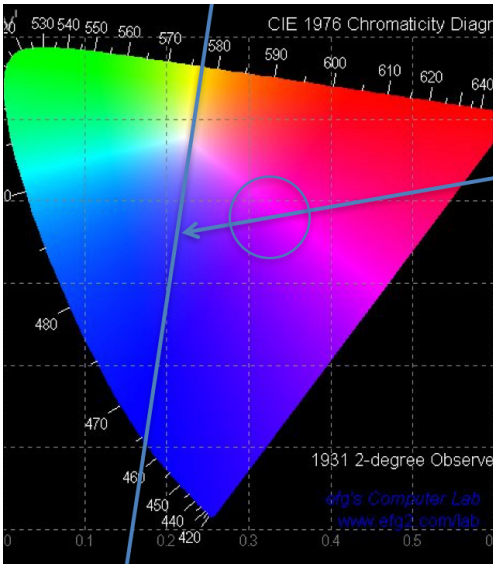


Figure 4.7 How perception of any colour in the spectrum is affected by red-green CVD can be seen by mapping that colour to the blue-yellow axis. To understand how magenta is seen, a line is drawn from the red corner, representing the red, or long wavelength cone, through magenta, to the blue-yellow axis. From this, it would be deduced that the magenta on that line will appear blue to those with CVD.

malfunctioning or variant cones (tritanomoly, protanomoly and deuteranomoly) colour perception becomes more specific to the individual and would generate a bespoke colour space that is harder to plot. A general approach can be made by considering the three axes of colour in the model.

Essentially, in red-green CVD, the red-green axis of vision is affected such that the distinction of colours along this axis cannot be made. The visible spectrum on this axis for deuteranopia and protanopia is similar being reduced to yellow-browns. All the colours on that axis appear as yellow-brown to someone with red-green CVD (Figure 4.6).

The range of colours visible on the blue-yellow axis are mostly unaffected because the short wavelength (blue) cones are fully functional. The resultant colour vision for red-green CVD can be imagined as a collapse along the blue-yellow axis, where the colours towards the yellow end are influenced only by yellow-brown.

The impact of how perception of any colour in the spectrum is affected can be seen by mapping that colour to the blue-yellow axis. For example, to understand how magenta is seen, a line would be drawn from the red corner, representing the red, or long wavelength cone, through magenta, to the blue-yellow axis. From this, it would be deduced that the magenta on that line will appear blue to those with CVD. Because the red perception is missing the magenta shifts to its other component hue, and is perceived as blue (Figure 4.7).

We can do the same with a line originating from the green corner, or medium wavelength cone. If we direct it through the green-blue or aqua we can determine that

aqua=blue for those with red-green CVD.

Blue-Yellow CVD

Less than 1 in 10,000 people have blue-yellow CVD (Colblindor 2017). Tritanopia and tritanomaly affects the short wavelength cones. The cones are missing in tritanopia and mutated in tritanomaly. Those with the condition, which is equally distributed between men and women, have difficulty discriminating between blue and green hues, and yellow and red hues (Figure 4.8). Because the absence of the unique colour detection of the short wavelength cones and the similarities of the medium and long wavelength cones neutral point, or white, occurs close to yellow; green is perceived as short wavelengths (blues) and red as longer wavelengths (reds).

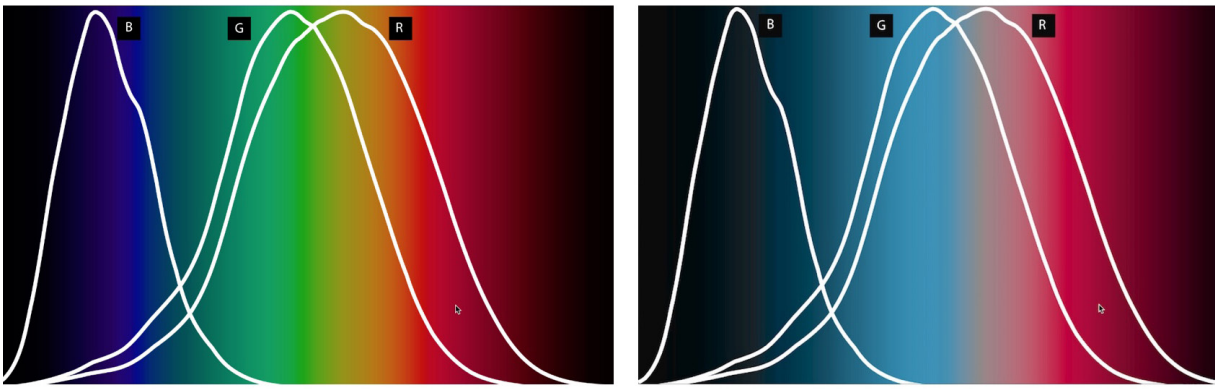


Figure 4.8 Colours as detected by red, green and blue cones for the typically colour sighted on the left. A simulation of colours detected by red, green and blue cones for blue-yellow CVD on the right.

Greens are seen as blues and yellows are seen as reds. Because of the distinct colour detection of the blue cone, the plotting of the line of colour collapse is an arc rather than the fairly straight and similar lines used to approximate deuteranopia or protanopia (Goldstein 2007) (Figure 4.9).

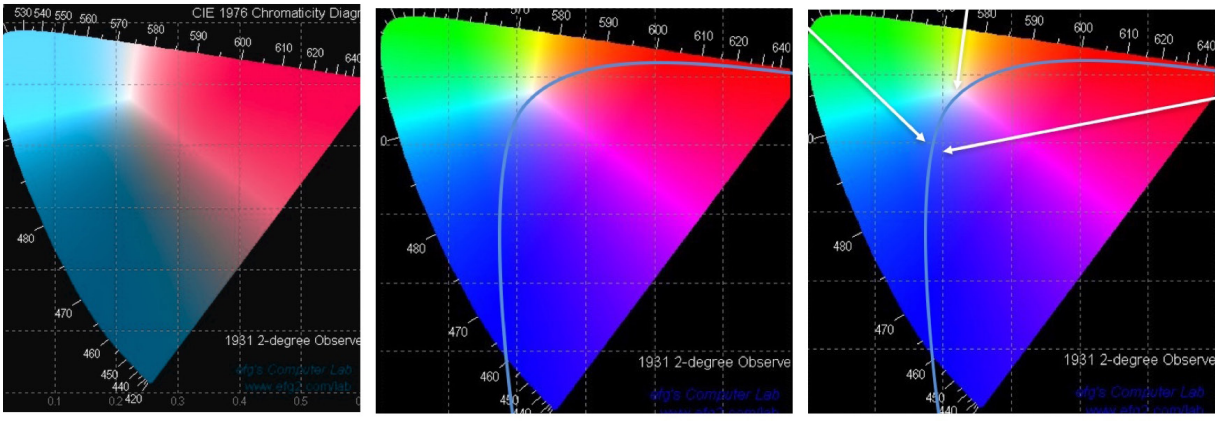


Figure 4.9. Right; a tritanopia simulation of the CIE colour space. Centre; the line represents where colours collapse for tritanopia. The arrows show where green collapses to blue, yellow to white and magenta to blue.

4.2 APPROACHING THE WORK

4.2.1 Imagery

The two sets of diptych prints in the *Colour Blind Test: Heaven and Hell* and *Sheep and Goats*, rely on imagery inspired by the *Ishihara Test* and lyrics from *Sheep Go to Heaven* by the rock band Cake. Both the imagery and text were adapted, in part, because of their overt dichotomies; the Ishihara test is a tool to identify one as colour sighted or colour blind. The Cake song, seemingly inspired by the Biblical parable in Matthew 25, declares “sheep go to heaven, goats go to hell (Cake 1998). The use of this imagery and the incorporation of words intentionally relates this work to the previous print series; this being a further investigation of discoveries made there.

4.2.2 Dualism

The prints of Colour Blind Test visually and compositionally play with the theme of dualism, portraying the inherent contradictions in the classical dualistic perspective. The notion of dualism drove the themes of the study. Colour sighted and colour blindness itself is dualistic. One sees colour or one does not. The prints conversely use colour so that those with typical colour sight do not first see things obvious to those with CVD. This was inspired by Ishihara’s embedding of different numbers for the typically sighted and those with CVD. In Plate 9 of the *Ishihara Test,* the number 74 is identifiable to those with typical colour sight, while the number 21 is visible to those with red/green CVD (Ishihara 1917). *Colour Blind Test Series* does something similar by incorporating patterns differentially visible for the typically colour sighted and those with CVD.

The contrast of dualism against the inclusiveness of audiences and the mysteries of hidden messages was deliberate and harkens back to William Blake’s book; *The Marriage of Heaven and Hell*. Blake turns the dualistic Biblical proverb of the sheep and goats on its head by declaring that, “the lust of the goat is bounty of God” (Blake 1790).

The lyrics of the Cake song are printed in clear varnish over the Ishihara imagery, and are intended to enforce the ideas of hidden messages and the dualist nature of the work by appearing and disappearing according to the position of the viewer and the light source.

4.2.2.1 Parable of the Sheep and the Goats

In the Biblical parable, God separates his metaphorical flock, into sheep and goats. The sheep are kind to others and listen to God. They are placed on his right side and are bound for Heaven and eternal life. The goats are not kind and do not listen. They are placed on his left side and condemned to Hell and eternal punishment.

4.2.2.2 Sheep Go To Heaven

The lyrics of *Sheep Go to Heaven* play with the dualistic approach of the parable of The Sheep and The Goats declaring; “love has started to fade,” and “the carpenter

Lyrics:
Sheep go to Heaven
Cake, 1998

I'm not feeling alright today
I'm not feeling that great
I'm not catching on fire today
Love has started to fade
I'm not going to smile today
I'm not gonna laugh
You're out living it up today
I've got dues to pay
And the gravedigger puts on the forceps
The stonemason does all the work
The barber can give you a haircut
The carpenter can take you out to lunch
Now I just want to play on my panpipes
I just want to drink me some wine
As soon as you're born you start dyin'
So you might as well have a good time
Sheep go to heaven
Goats go to hell
Sheep go to heaven
Goats...go to hell
I don't wanna go to Sunset Strip
I don't wanna feel the emptiness
Old marquees with stupid band names
I don't wanna go to Sunset Strip
I don't wanna go to Sunset Strip
I don't wanna feel the emptiness
Old marquees with stupid band names
I don't wanna go to Sunset Strip
And the gravedigger puts on the forceps
The stonemason does all the work
The barber can give you a haircut
The carpenter can take you out to lunch
Now but I just want to play on my panpipes
I just want to drink me some wine
As soon as you're born you start dyin'
So you might as well have a good time
Sheep go to heaven
Goats go to hell
Sheep go to heaven
Goats...go to hell
Sheep go to heaven
Goats go to hell
Sheep go to heaven
Goats...go to hell
Sheep go to heaven
Goats go to hell
Sheep go to heaven
Goats...go to hell

can take you out to lunch" (Cake, 1998). Love is not dead, but it is not strong either. It is in-between. The carpenter is not only a carpenter, but also other things, including a lunch companion and the Christ. The song goes on; "sheep go to Heaven, goats go to Hell" while the singer just wants 'to play on my panpipes" and to "drink me some wine" because "as soon as you're born, you start dying, so you might as well have a good time." He is neither sheep nor goat, not good or bad, but Pan just trying to get along.

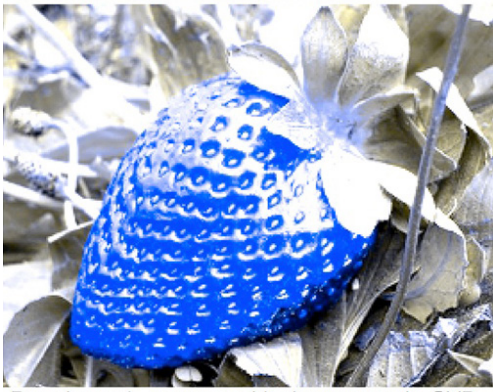
4.2.2.3 Lust of the Goat

I was put in mind of the dualism of the parable of sheep and goats by a text first used in *Double Blind Test Series, The Marriage of Heaven and Hell* by William Blake, whose title even seems to rally against it. In Matthew 25 some people are good, the right hand, they are like sheep, they will go to heaven. Some others are bad, the left hand, they are like goats, they will go to hell. It is difficult to argue against people who are kind to others being perceived as good, and people who are unkind as bad. However, people, like sheep and goats, are not just one thing, they are a multiplicity of things. Or, as William Blake puts it in *The Marriage of Heaven and Hell;* "the lust of the goat is bounty of God" (Blake 1790).

As seen with typical colour vision.

As seen with deuteranopia CVD.

Recoloured, as seen with typical colour vision.



Recoloured, as seen with deuteranopia CVD.

Figure 4.10 The recolouring tool maps the colour of the leaves and berries to a colour combination that is more differentiable for someone with CVD.

4.2.3 Software

Computers and tablets loaded with CVD simulation and recolouring software were used to see the artwork differently. David Flatla created a tablet based application that both simulates CVD and recolours for those with CVD allowing them to appreciate a wider range of colours for this investigation.

4.2.3.1 CVD Simulation Software

The CVD simulation software emulates the collapsing of the visual red-green axis of the colour spectrum experienced by those with CVD. A digital image of the artwork is captured by a video camera connected to a computer, or embedded in a tablet, and viewed in real time. The software identifies colours in the digital image, pixel by pixel, and substitutes those colours for the ones they collapse to on the blue/yellow axis.1

4.2.3.2 Recolouring Software

The recolouring for CVD software also acts on images captured by a video camera connected to a computer. It rotates the red-green-blue (RGB) colour representation used by the computer to green-blue-red. Consequently, red becomes green, green becomes blue and blue becomes red. For example, suppose an image contains red strawberries against green foliage. The recolouring tool maps the colour of the leaves and berries to a colour combination that is more differentiable for someone with CVD (i.e., red leaves and blue berries). This introduction of a false colouring scheme helps restores the perception of colour differences for people with CVD (Lyons and Flatla 2014) (Figure 4.10).

4.2.4 Colour Contrast

The colour and value contrasts that artists and designers use to help communicate visually were employed differently for my audiences. The typically sighted tend to visually group warm colours (reds and magentas) and cool colours (blues and greens) separately (Figure 4.11). Thus, contrast for the typically sighted can be created using cool colours and warm colours. Those with red-green CVD exhibit different colour grouping preferences. They tend to group what those with normal sight view as red and green colours together because to them, they all appear as muddy yellows. Similarly, blues and magentas are grouped together because they all appear blue. Colour contrasts for these audiences are most easily made using blues and yellows (Figures 4.12, 4.13 and 4.14).

So, groups of similar colors for the typically sighted might include these:

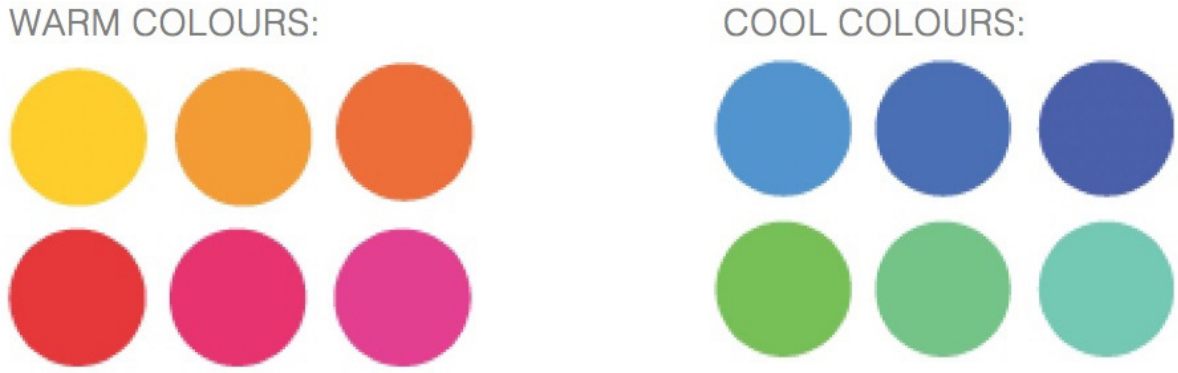


Figure 4.11 Yellow, orange, red and magenta are grouped together. Blues, greens and aquamarine are grouped together.

As seen by those with red-green CVD, those same colors appear as:

Figure 4.12 The orange and red has shifted towards a similar yellow-brown as the greens. The magenta has shifted to a grey blue.

Groups of similar colors for those with CVD might include these:
As seen by those with CVD:

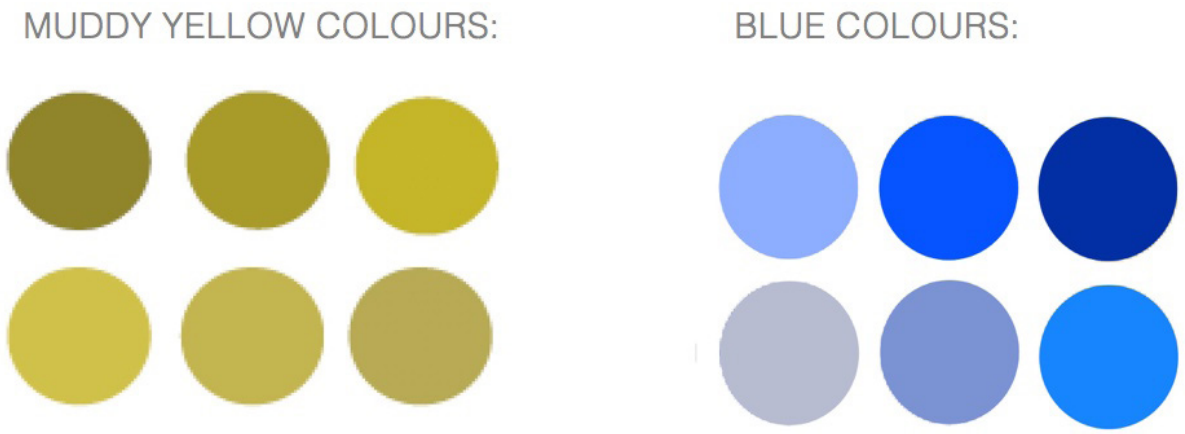


Figure 4.13 Various muddy yellows contrast strongly against the blues.

As seen by those with typical color sight:

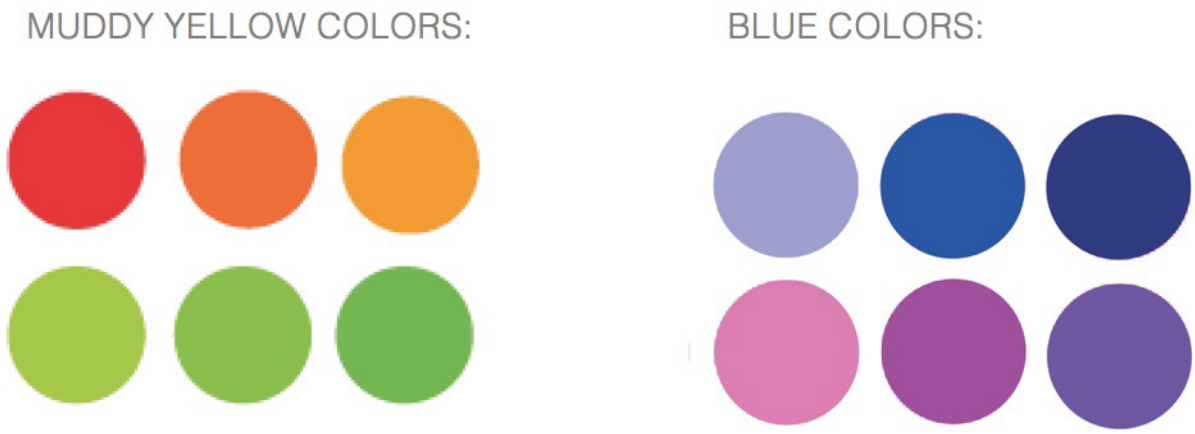


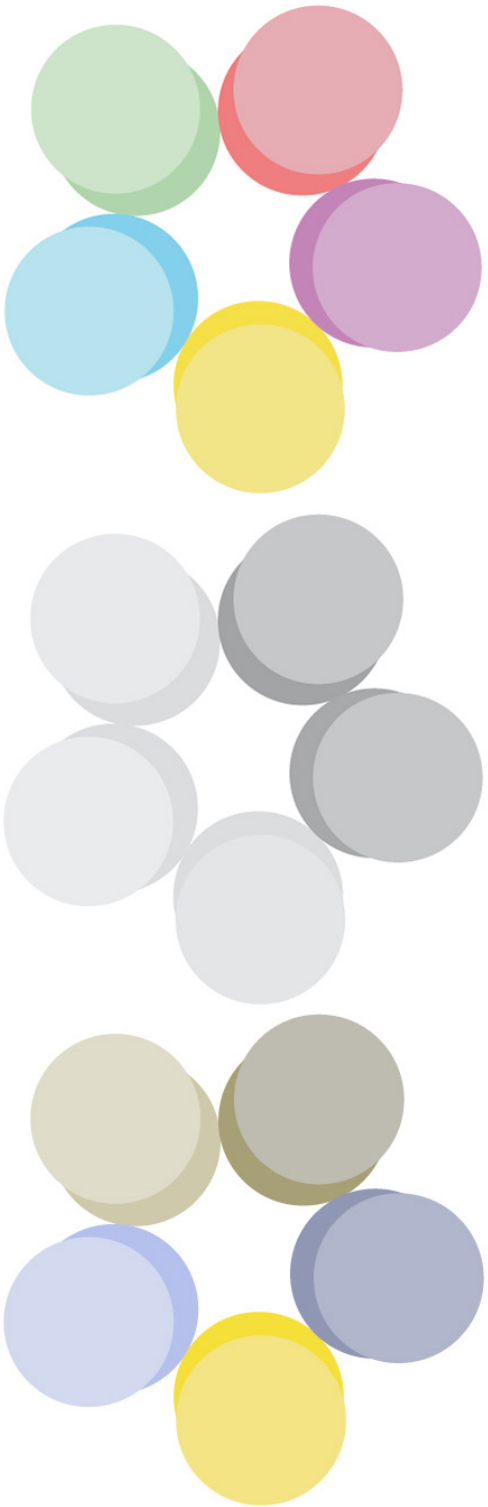
Figure 4.14 To the typically colour sighted warm and cool colours make up both the muddy yellow and the blue groups.

This colour perception variation was used in the prints to create different visual experiences. Knowing how these two ways of seeing and grouping interact with each other through contrast facilitated targeting of the different audiences. Grouping the colours strategically allowed the creation of messages to one audience that were camouflaged to the other.

4.2.5 AUDIENCES, COLOUR IDENTIFICATION AND TESTING

4.2.5.1 Audience selection

I chose to direct my work at 2 main audiences: those with normal vision and those with the deuteranopia form of red-green CVD. Deficiencies in the medium wavelength cone account for 75% of the instances of CVD. Deuteranopia, where the cone is missing, has a predictable colour perception profile. Although more common, deuteranomaly colour profiles are specific to each individual because, rather than missing, the green sensitive cones have peaks of sensitivity shifted towards red. Tailoring my work to the more predictable deuteranopia allowed me to target the largest possible group. Those with other red-green CVDs, deuteranomaly,



Figures 4.15 Left: Initial colours for heaven, adjusted for value. Centre: Value profile. Red and magenta have similar values as do green and blue. Right: CVD simulation. Magenta has shifted blue, green and red to yellow-browns.

protanopia and protanomaly, see similar colours to those with deuteranopia, but with variations that are either difficult to predict or affect a very small population. By designing for deuteranopia the intended effects would be perceived by the largest audience possible with some or most of the effects visible to those with other red-green CVD conditions.

4.2.5.2 Colour Identification
Using the colour contrast groupings described previously and the CIE Colour Space, one each of complimentary red, magenta, blue and green hues were chosen. Using the CVD simulation and *Digital Color Meter* softwares, the colours that the each of those hues shifted for those with deuteranopia were identified.

In addition to colour contrast, it was reasoned that value contrast could play a role in visual colour grouping, helping convince both those with typical sight and those with CVD that the colours that they were seeing should be visually grouped in a particular way. Knowing how these two ways of seeing and grouping interact with each other through contrast facilitated targeting of the different audiences. Grouping the colours strategically allowed the creation of messages to one audience that were camouflaged to the other (Figure 4.15).

4.2.5.3 Quantitative Feedback
To ensure that the prints were experienced differently dependent on visual ability, the imagery was tested on a self-identified red-green CVD cohort. Of the eight volunteers who identified themselves at presentations of my work, two knew their CVD diagnosis. One had protanomaly, the other deuteranopia. For the test, each was emailed a JPG of a work in development and asked “Can you

let me know if you see any letters, numbers or patterns in the image?" Because of two types of red-green and individual variations, once an intended pattern was firmly identified, as predicted by the software, by a significant portion of the test group, the test was considered successful and that variant would become the final image for the print. Because of the similarity of the colour schemes used in the prints, only the first image required multiple tests.

4.3 SHEEP/heaven

The first application of my red/magenta and green/blue groupings was done as a hidden word experiment; SHEEP/heaven.

I laid out a grid of 7500 squares. The squares worked as pixels in the creation of text for two words: SHEEP and heaven. I created the word SHEEP out of blue and green squares on a background of red and magenta squares. Integrated into that same page was the word heaven created out of blue and magenta pixels on green and red background.

Figure 4.16 Right: Original colours. 'SHEEP' is legible to those with typical colour vision. Left: CVD simulation. 'heaven' is legible to those with deuteranopia.

Those with typical sight first saw the word 'SHEEP'. Those with red-green CVD first saw the word 'heaven'. The results matched my intention and I proceeded on to the prints (Figure 4.16).

4.4 HEAVEN AND HELL

After establishing that the four colours of the print would be the differentially associated red, magenta, green and blue, I chose the specific hues based on my aesthetic preferences and then adjusted for value. The dot template developed for *Double Blind Test Series* (see 3.2.4) was used after a revision to eliminate the numerical Braille area in the larger circle and the Braille title area in the lower quarter.

Figure 3.17 Hell used the same process but rotated by 90 degrees such that the stripes recognized by CVD viewers were horizontal.

Horizontal and vertical guides were introduced to the template such that vertical and horizontal bands were formed. For *Heaven*, the dots occupied alternating horizontal bands of red and magenta, and green and blue. Importantly, the green areas aligned with red filled areas and the blue with magenta. When viewed with deutaneropia, this created vertical stripes of muddy yellow and blues (Figure 3.17).

4.5 SHEEP AND GOATS

To differentiate the colours for *Sheep and Goats*, four slightly lighter tints were created from the original four hues. Instead of stripes, the pattern made by the coloured dots of red and magenta was concentric circles, separated by circles of green and blue filled dots. The pattern made by the adjoining magenta and blue dots, and red and green dots, is of chevrons pointing up in *Sheep* and down in *Goats*.

4.6 EXHIBITION, PUBLIC ENGAGEMENT AND RESPONSE

4.6.1 Exhibition

4.6.1.1 Hannah Maclure Centre Gallery Colour Blind Test was shown in *Eye for an Eye*, an exhibition of my work at the Hannah Maclure Centre Gallery, Abertay University, Dundee Scotland, 28 Jun through 4 July 2014 (Figure 3.18). The exhibition comprised Colour Blind Test along with two other works, *Eye for an Eye* and *Triple Blind* (both discussed in the next chapter) accompanied by tablets loaded with CVD simulation and recolouring software available to viewers (Figure 3.19). Many of the media tests used for the creation of these pieces, including motion graphics shown on old CRT monitors, occupied the main gallery along with the finished work. It was part of Dundee's city wide response to *Generation*, a Scotland wide Commonwealth celebration

of contemporary visual art. 718 people attended over the seven-day run of the show (numbers as recorded by the HMC Gallery).

Figure 3.18 Sheep and Goats exhibited at the Hannah Maclure Centre Gallery, 2014 Dundee Scotland.

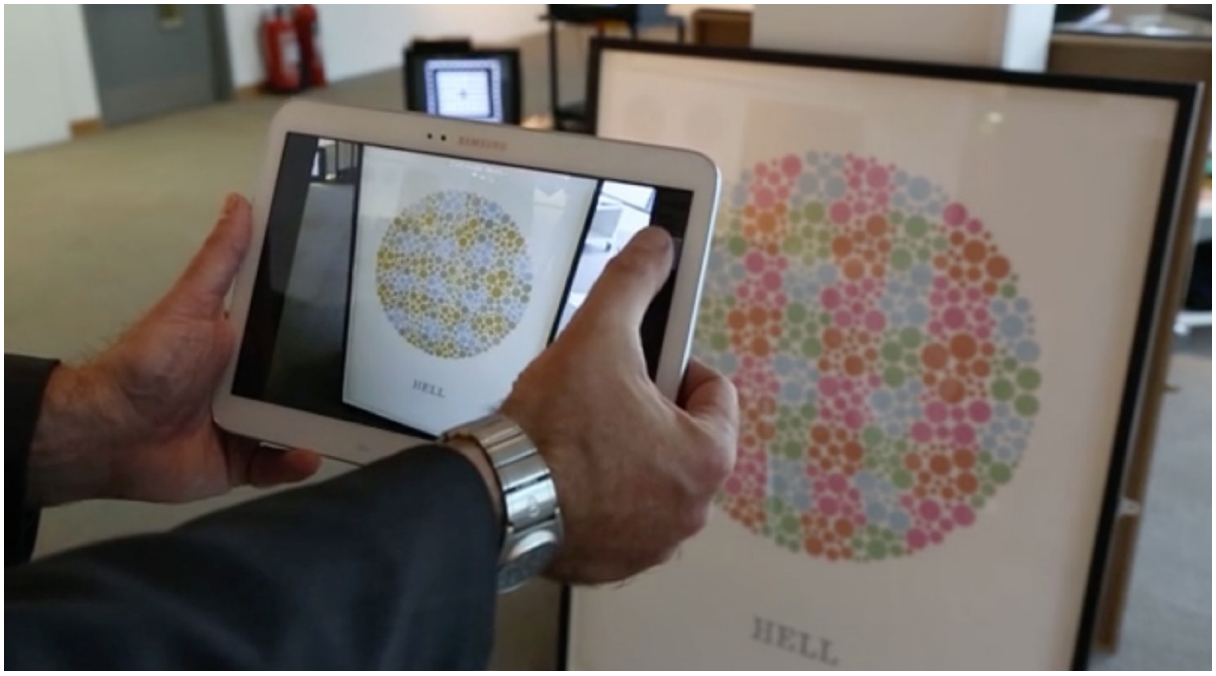


Figure 3.19 Tablets loaded with CVD simulation and recolouring software available to viewers allowing visual experiences to be shared.

4.6.1.2 Queen Mother Building Gallery

Colour Blind Test, accompanied by computers and tablets loaded with CVD simulation and recolouring software, were exhibited at the University of Dundee's Queen Mother Building Gallery, 15 August 2014 – 31 January 2015, as part of the International Association of Word and Image Studies (IAWIS) Tenth Triennial

Conference. The paper, *The Colour Blind Test Series: Hiding Messages in Plain Sight*, was also presented at the conference.

4.6.2 PUBLIC ENGAGEMENT
4.6.2.1 NEON
On 5 Nov 2014, I gave a public lecture on *Double Blind Test Series* for *Electric Bookshop* as part of the NEON Festival of Digital Art, Dundee Scotland.

4.6.2.2 Dundee Science Festival
On 6 November 2014, I presented a public lecture on the science behind *Double Blind Test Series* entitled *Do You See What I See* as part of Dundee Science Festival, Dundee Scotland.

4.6.3 RESPONSE
4.6.3.1 Documentary
Colour Blind Test, as exhibited in *Eye for an Eye*, was the basis of a 3.5 minute documentary film by colour blind filmmaker Ben Grieves. It was created for Summerhall's *Art In Scotland TV*.

4.6.3.2 Philosophical Essay
Eye for an Eye was attended by philosopher Martin A. Lipman. Dr. Lipman has deuteranopia. His work investigates perception and he found a kinship in the themes of my work. In response to the exhibition he wrote, and presented to me, *Fewer Looks or Alien Looks*, a personal reflection of the effects of *Eye for an Eye* on his understanding of perception.

4.7 FINDINGS
Through the use and understanding of colour, artistic principles and computer science applications, the two diptychs (*Heaven and Hell, Sheep and Goats*) were created with the aim of understanding vision's influence on perception and with the intent of communicating different individual elements to targeted audiences of specific visual abilities.

During development and exhibition, test cohorts and audiences interacted with the art differently, as expected. The general tone of comments was that of enjoyment. The titles of the prints generated many positive comments as did the interaction spurred by the software.

Attendees with normal vision were engaged by the work with its familiar imagery and the changing surface texture resultant from the varnish printed text. When using the tablets containing the CVD simulation software the comments "this is very interesting" and "I never know things looked so different for the colour blind", were noted.

For those with CVD in attendance, there was a sense of delight, particularly prevalent once they were prompted to ask others with typical colour sight to discuss what was seen in the prints and then use the software on the tablets to translate their experiences between each other. One couple in particular became very engaged in the prints and the software/tablet translations, she of typical colour vision and he, CVD. In conversation, it was learnt that their vision differences had been of interest to them throughout their relationship. And, according to them, the exhibition had been a strong step towards an understanding of each other's perceptual experiences.

Rudolf Arnheim, in *Visual Thinking*, declares that "visual perception is visual thinking" (Arnheim 1969, p 13). Colour Blind Test advances that proposition, and concurrently disrupts the notion of duality.

In his assertion, Arnheim disputes the conventional psychological view, which excludes the activities of the senses from thought in the interest of a theoretical model that separates as data the information received by the senses for its treatment by the mind. This division, it would seem, is based in the classic ontological dualistic proposition of mind and body. *Colour Blind Test* contradicts this.

Seeing the work provides cognition of the work. Those with typical colour sight saw horizontal lines in *Heaven*. Those with deuteranopia saw vertical bars. If one has different visual experiences than another of a work of art, their understanding of the work will also be different. The success of the *Colour Blind Test* in providing a multiplicity of appearances due to viewers striving for order through their variances of sight, I believe supports Arnheim's view. Seeing, he says, is the perceptual task of extraction. And he continues, that perception "offers visible proof that all things are in a flux of constant modification" (Arnheim 1969, p 53). The order that we perceive in *Colour Blind Test* may only be our order, as effectively illustrated by the tablets with the CVD simulation software, but others may extract another.

The arguments with dualism, as manifest in the work through its binary titles, texts' religious connotations, format and visual polarities, ultimately illuminate the contradictions of the separation of mind and body/thinking and sensing. Heaven for the typically sighted is calm horizontals, for those with CVD its bold verticals. For the typically sighted, both *Sheep* and *Goats* have been targeted, for those with CVD *Sheep* points down towards hell while *Goats* point up towards heaven.

The ability to embed these multiple interpretations within the same pieces, both literally and metaphorically, has been very satisfying and well worth future investigation.

However, my key concern was the artistic exploration of perception and its connection to sight and the other senses. This is what I do in Chapter 5.0.

Notes

[1] The illustrations are two dimensional representations of the three-dimensional CIE colour space. In the illustrations, we see a somewhat distorted view representing a red-green axis and a blue-yellow axis. In the three-dimensional colour space, there is also an orthogonal black-white axis to account for value changes.

References

Arnheim, Rudolf. *Visual Thinking*. Berkeley, University of California Press, 1969.

Blake, William. *The Marriage of Heaven and Hell.* Copy D, 1795 (http://www.blakearchive.org/copy/mhh.d?descId=mhh.d.illbk.03)

Cake. 1998. Sheep Go to Heaven, *Prolong the Magic*. Capricorn.

Colblindor. 2017. Available from: http://www.color-blindness.com/ [Accessed 20 May 2017].

Colour Blind Awareness. 2017. Available from: http://www.colourblindawareness.org/colour-blindness/ [Accessed 24 May 2017].

Goldstein, B. 2007. *Sensation and Perception*, 7th edition. Belmont, Thomson Wadsworth.

Hecht, S. 1937. Rods, cones, and the chemical basis of vision. *Physiological Reviews* (17.2 pp. 239-290).

Hurvich, L. 1981. Color Vision. *Color Research and Application* (Vol. 7 Issue 3, pp. 328-333).

Ishihara, S. 1917. *Ishihara Test for Colour Deficiencies: 38 Plate Edition*. Tokyo, Hongo Harukicho.

Livingstone, Margaret. *Vision and Art: The Biology of Seeing*. New York, Harry N. Abrams, 2002.

Lyons, D. and Flatla, D. R. 2014. *Eye for an Eye*. In: K. Ng, S. McDaid and J. Bowen (eds), Proceedings of the Electronic Visualisation and the Arts, London, UK, July 8-10. pp. 49-55

Smith, T. and Guild, J. 1932. The C.I.E., *Transactions of the Optical Society* (Volume 33, Number 3).

EYE FOR AN EYE AND TRIPLE VISION

5.0 STUDY FOUR: EYE FOR AN EYE AND TRIPLE BLIND

In *Eye for An Eye* and *Triple Vision* I sought to advance my perceptual interrogation through the introduction of movement, using motion graphics animation, and sound. *Eye for An Eye* was created in continued collaboration with computer scientist David Flatla. For Triple Vision, there was additional collaboration with Manchester based sonic artist and musician Raz Ullah.

5.1 EYE FOR AN EYE

This study's ambition was to advance the perceptual explorations of embedding multiple visual interpretations to specific visual acuities to animations, through applying the techniques established in *Colour Blind Test*. The research questions continue: *Can artwork be intentionally created to be experienced differently dependent on one's visual abilities? If so, can those experiences be shared?*

To that end, three animations were created. The first two animations are unique and the third is an interlacing of the other two.

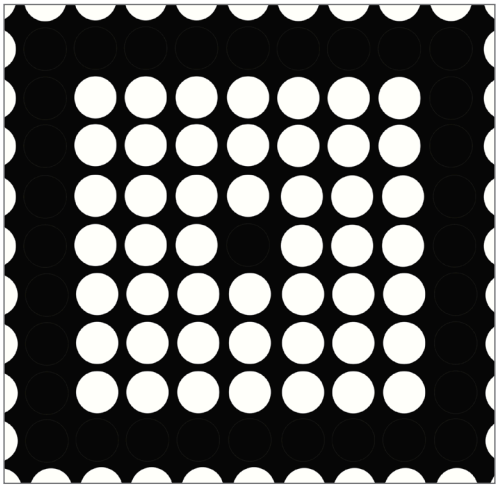
5.1.1 The Imagery

The animations in *Eye for An Eye* reference the circles of the *Ishihara Test* used in the previous print series, as well as the animated movie marque and Las Vegas signage of the 1970's (thekinolibrary 2014). In such signage and movie marques, lights are turned on and off in a sequence to create the illusion of motion. Rather than be turned off and on, the circles in the *Eye for An Eye* change colour in a way that generates unique experiences for viewers with different colour acuities. Similarly, to *Colour Blind Test*, the software

allows the experiences to be shared. The Ishihara inspired imagery is again used to help convey themes of colour perception. The colours used rely on the formulas developed for the print series described in Chapter 4.0, (e.g. for typical sight blue is visually grouped with green and red is grouped with magenta. For red-green CVD, red is visually grouped with green and blue is grouped with magenta).

The first animation was planned to have a green numeral 6 against a radiating red and brown background visible to those with typical sight. Conversely, those with CVD would see only a still image. For the second animation, those with CVD would see a 6 in the centre of a flickering background, while those with typical sight would not see the 6, instead seeing blues and magentas radiating alternately from the centre of the circular image. The third animation was composed of alternate views of the first two animations such that the 6 is first visible only to those with typical sight and then to those with CVD.

Before creating the three animated pieces, it was necessary to prove the principle that the desired animation effect could be created through sequenced patterns of dots. Therefore, the first stage was to create a sequencing test.



5.1.2 Building and Testing

5.1.2.1 Proof of Principle Sequencing Test

In order to establish that sequencing would produce the desired motion effect, images comprised of simple square grids of 81 white circles against a black background were created in Illustrator. A sequence of three white circles followed by one black was produced. Four images were created with the position of the black circles moving

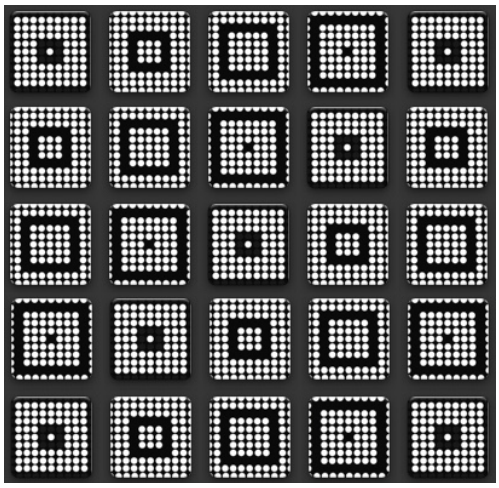


Figure 5.1 The on/off sequence can be read from left to right, top to bottom.

away from the centre with each progression. A still of this repeated sequence is shown in Figure 5.1.

The sequence comprises four still images, placed in order and repeated. This sequence was saved and placed in correct order into *Adobe Premiere* video editing software. Initially each still in the sequence was given six frames. The 6 frames of each image were then copied and pasted multiple times into the project window of Premiere. When played at the standard 29.97 fps, the sequence gave the impression of a square rapidly radiating out from the centre of the image. The sequence was looped to play continuously. The effect was of light radiating out from the centre of the image.

5.1.2.2 Identifying the Colours
Colour Selection for the First Animation
To achieve a dynamic animation for the typically sighted, while looking motionless to those with CVD, the colours had to be precisely identified. For this, the knowledge of the different manifestations of colour for the typically colour sighted and colour blind as learned in Chapter 4.1.3 was used. This allowed selection of red and yellow-brown colours that would correspond with green exactly, such that all would appear the same exact yellow-brown to those with deuteranopia CVD.

In Illustrator, a green and red hue of similar saturation and value were chosen. Two circles were created: one filled with the red and the other with the green. Using the *Color Blindness Proof* setting in *Illustrator* both circles were visualized in the yellow-brown hues of CVD. The green circle was used as the key and the RGB percentage of its simulated yellow-brown measured using the *DigitalColor Meter*. A third circle was filled

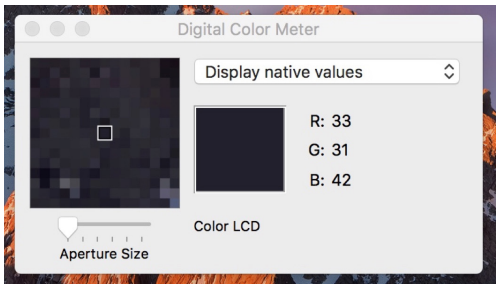


Figure 5.2 RGB percentages are shown of any color the computer's cursor is place over.

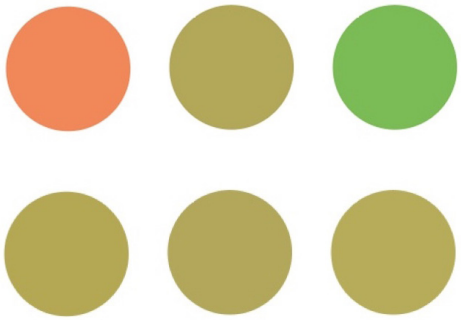


Figure 5.3 Top: Colours as seen by those with typical colour vision. Bottom: Same colours as seen by those with CVD.

with that yellow-brown.

To generate an identical yellow-brown hue from the red circle, the RGB percentages of the original red hue were manually adjusted in Illustrator until the correct yellow-brown hue was visualised through *Illustrator's Color Blindness Proof* setting. This entailed slightly changing one of the RGB percentages in *Illustrator* then switching to the *Color Blind Proof* setting. Because Illustrator gives only the RGB values for the red, even when in the *Colour Blindness Proof* setting, a reading of the RGB values from the *DigitalColor Meter* was required to tell if it adjusted closer to or further from the percentages needed for the red to match the yellow-brown hue (Figure 5.2).

This process of adjustment was repeated until the *Color Blindness Proof*'s red, and yellow-brown hues matched. The adjusted red was shifted to a red-orange by this process. The result is a unique set a of red-orange, green and yellow-brown hues that when simulated for CVD are an identical yellow-brown colour (Figure 5.3).[1]

Colour Selection for the Second Animation
The intent for the second animation was to create a blue number 6 against a shimmering yellow-brown background visible only to those with CVD. Those with typical colour sight would instead see a radiating circular radiating pattern of alternating warm and cool colours and no number.

To get a variety of workable hues for the second animation, the colours from *Colour Blind Test* (4.4. Heaven and Hell) acted as a starting point, being proven effective in communicating to both the typically sighted and those with CVD. Because *Colour Blind*

Figure 5.4 Top: Colour as seen by those with typical colour sight. Bottom: Colours as seen by those with CVD

Test colours were used for prints, samples of the colours were created in Illustrator and adjusted to be web compatible ensuring reproducibility in a variety of digital media formats. One red and one green tonal variant, as well as one yellow hue, were identified and added to the colour palette to provide visual interest and aid in camouflaging the hidden number. The colours were tested in *Illustrator's Color Blindness Proof* setting to insure the chosen magentas adequately shifted to blue and the red and greens adequately shifted to yellow-browns, to those with red-green CVD (Figure 5.4).

5.1.2.3 Creating and Testing the Art First Animation

Using the dots within the Ishihara inspired imagery, a large green number 6 was created. The 6 does not change or move in this animation. To achieve the radiating motion of the background I adapted the 'on and off' principles used in the sequencing test.

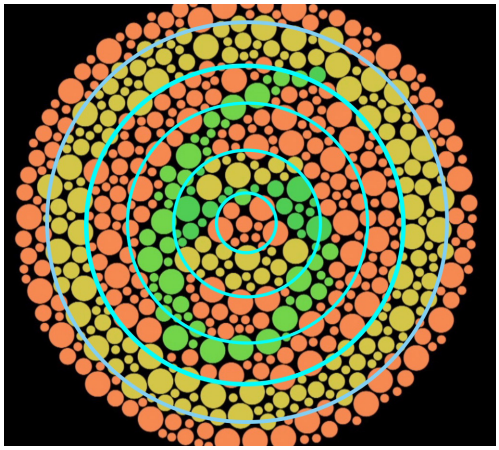


Figure 5.5

Because the dots in the Ishihara imagery are neither uniform nor laid in a grid, concentric circular guides were overlaid on the imagery. If the centre of an Ishihara dot fell within a specified concentric demarcation, then that Ishihara dot was included within that zone. This generated imperfect circles that better reflected the Ishihara characteristics whilst maintaining an organized structure (Figure 5.5).

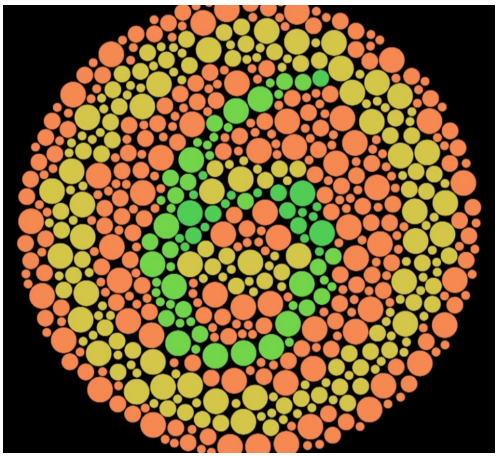


Figure 5.6 The circular demarcations, in steps of four (off, on, on, on). The yellow-brown colour acting as 'off' in the sequence, the red working as 'on'.

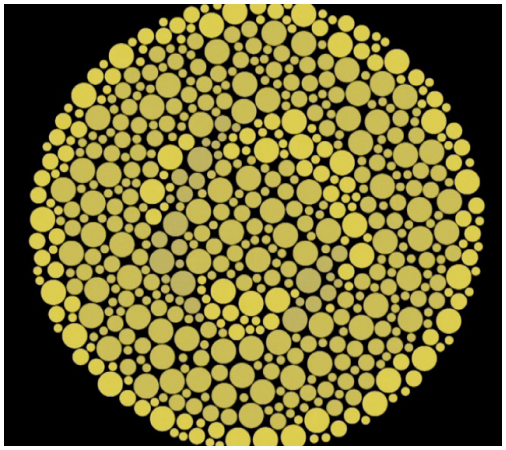


Figure 5.7 The mo tion graphic appears as a stagnant brown-yellow to those with CVD.

Using the circular demarcations, the colours of the Ishihara dots were sequenced in steps of four (off, on, on, on). The yellow-brown colour acted as 'off' in the sequence and the red as 'on' (Figure 5.6).

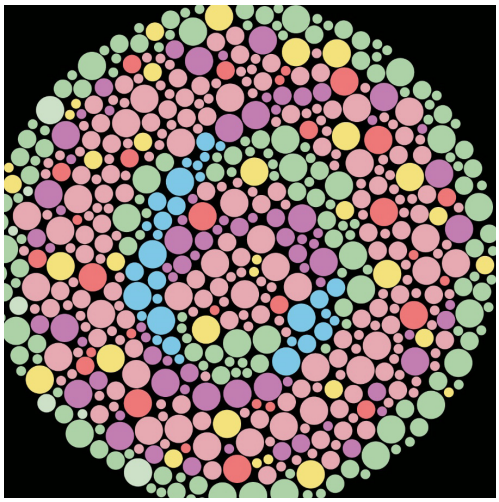
This sequencing of colour was repeated in advancing steps four times, with each saved individually as a unique image. In each consecutive image, the yellow-brown 'off' colour advanced outwards by one concentric circle and its previous position resumed by the red 'on' colour. The four individual still images of the sequence were saved and placed in their correct order into *Adobe Premiere* video editing software. Initially each still in the sequence was given ten frames. This was then looped to create a continuous progression. The effect to the typically sighted was of alternating bands of red-orange and yellow-brown radiating out from the centre of the image.

Once the motion graphic was completed, a desktop prototype of David Flatla's CVD simulation software was used to view the motion graphics as they played on the computer screen, and judge the success of the effect planned for those with CVD (figure 5.7).

After the animation performed as expected in simulation, it was shown to two local text subjects, one with typical colour sight and the other with deuteranopia. The local test subjects were able to describe the effects as intended, and the results were considered successful.

Second Animation

The plan of the second animation was a blue number 6 against a shimmering yellow-brown background visible to those with CVD. Alternatively, those with typical colour



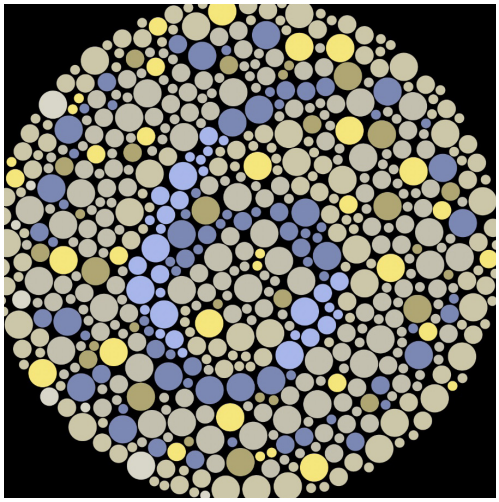


Figure 5.8 Top: The green colour acting as ‘off’ in the sequence, the red working as ‘on’.

Figure 5.9 Bottom: Same image as Figure 5.7, but simulated for deuteranopia. Blue 6 visible to those with CVD, but the greens and reds have shifted to yellow-greys.

sight would see radiating red and green circular bands. Using the dots within the Ishihara inspired imagery, a large number 6 was created, but in blue and magenta. Using the same concentric circular guides as the first animation, the colours were sequenced in steps of four (off, on, on, on). The green colour acting as ‘off’ in the sequence, the red tints working as ‘on’. Once the colours were placed in the sequences, yellow dots were intermittently distributed throughout to increase visual interest and help camouflage the number 6 (Figure 5.8).

In this animation, to hide the 6 from those with typical colour sight, the colours of the 6 change as the alternating circular bands of green and red move through it. When the green band moves thorough the 6, the colour remains blue. When the red band moves through the 6, that section of the 6 within the band changes to magenta.

Once the animation was complete, it was tested with the CVD simulation software. Here it was noticed that the reds and greens of the radiating circular bands appeared more green shifted greys than muddy yellows. The effect of a blue 6 with a shimmering background was achieved, but the blue six was now against a yellow-grey background rather than a yellow-brown background. The animation was shown to the local CVD test subject and he reported the same. The desired affect was achieved. The number 6 was seen by those with CVD and those with typical colour sight did not see the 6 but rather circular radiating bands of greens and reds. The yellow-greys were left as they were and no attempt was made to adjust them (Figure 5.9).

The yellow-grey colours, through further investigation, were the result of two changes. First, to ensure that the colours would be seen similarly on a variety of platforms, the original colour choices were shifted to web compatible colours, which in some cases shifted the hues slightly. Second, was gamut shifts caused by the translation of CMYK colour in *Colour Blind Test* prints and the RGB colour used on computer screens.[2] Although originally identified as RGB colours in the initial layouts, for production, the *Colour Blind Test* print colours were translated into CMYK colours. Those CMYK colours where then translated back into RGB colours for this animation. Certain attributes of the original colours were lost in translation.

Third Animation
The third animation consisted of portions of the first and second animations edited together and looped.

5.2 TRIPLE VISION

Triple Vision continued the collaboration with computer scientist David Flatla with the additional collaboration of sound artist and musician Raz Ullah.

Triple Vision incorporates the animations of *Eye for An Eye* into prints. It consists of three identical black and white prints based on imagery from *Double Blind Test Series* that, when combined with the *Eye for An Eye* motion graphics spatially mapped onto their surfaces, create potent visual experiences for both colour blind and typically sighted audiences. Expanding perceptual exploration, *Triple Vision* adds sound with its accompanying audio soundscape. Companion smart devices programmed with the CVD simulation and recolouring software were provided to visually translate the experiences between audiences, thereby adding further levels of interaction.

5.2.1 Inspiration

The desire to exhibit *Eye for An Eye* cohesively with previous works lead to the development of the motion graphics being projected onto black and white prints that mirrored those motion graphics. Throughout the studies and investigations of *Double Blind*, prints had proven effective in communicating to those of varying visual acuities. The projection of the *Eye for An Eye* animations onto prints presented itself as an inventive solution and an innovative development in the research. To realize this, Raz Ullah was recruited for his technical expertise, which was further exploited with the addition of the accompanying soundscape.

5.2.2 The Triple Vision Prints

The three prints of *Triple Vision* are 86 x 86 cm black and white inkjets printed onto Somerset Enhanced Velvet 330 gm paper. The prints are devoid of colour and, unlike all the prints to this point, used black instead of white for the background/ negative space. No colour beyond the white of the paper and the black of the inks was used on the prints, allowing each of the white spaces to act as reflective

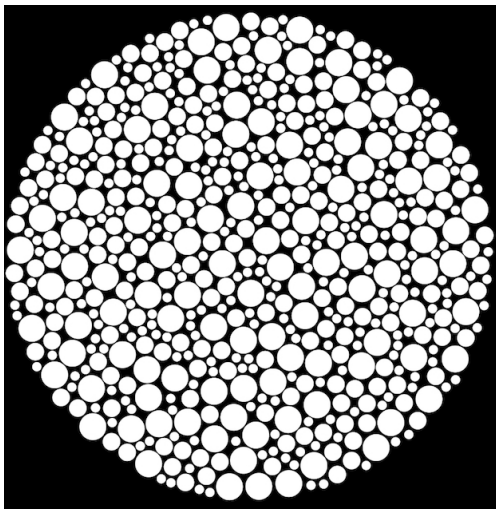


Figure 5.10 No colour beyond the white of the paper and the black of the inks are used on the prints.

screens for projected circles of changing colour (Figure 5.10).
Projecting only black onto the black areas of the prints and the colours of the animations onto the white area achieved a very high contrast between the brightly coloured areas and the saturated black areas.

5.2.3 Motion Graphics and Projections
Triple Vision uses the animations of *Eye for an Eye*, in combination with projection mapping. This video projection technology allows the user to position, scale and distort video content via a software interface so that it can be displayed on 2D or 3D objects

For the purposes of its initial installation VPT6 was used – a free, open source projection mapping software system developed by Norwegian video artist HC Gilje (Gilje 2010). VPT6 can display eight different video streams, each of which can then be positioned and scaled to accurately fit the surface onto which they will be projected.

The first stage of the process, taking place in a darkened cinema space, involved positioning the projector so that it covered the entire area where the prints were displayed – a distance of six metres from the easels holding the prints was sufficient. The three motion graphic videos were then loaded into the software interface, assigned to three different output layers and set to loop indefinitely. Each graphic was then positioned roughly over each print, ready to be precisely mapped onto the corresponding white dots. This final stage of the process required two people – one to operate the software and the other to stand close to the prints and give feedback as to how many increments the graphics had to be re-sized to fit.

Once each graphic had been positioned correctly, the effect was very dramatic with each print seemingly becoming more ‘active’ and reminiscent of a lighting display rather than a static print. The deep black around the white dots was highly effective in absorbing much of the light from the projector, with the result that the main body of the print became very bright. This, coupled with the installation being set up in a completely dark space, created a highly engaging visual environment (figure 5.11).

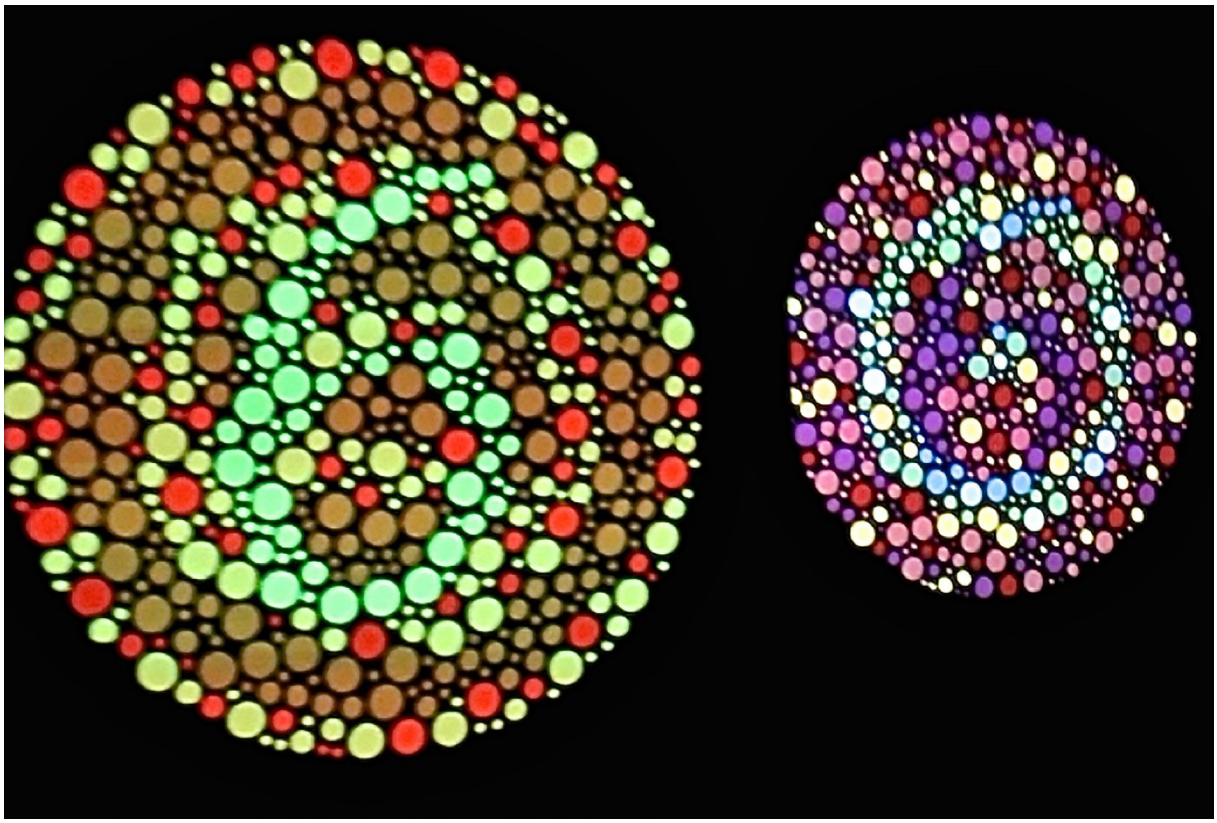


Figure 5.11 Two of the three projected motion graphics of Triple Vision.

5.2.4 Soundscape

The sound piece that accompanied the projection-mapped prints aimed to create an immersive environment that would both draw visitors into the space and heighten their interaction with the prints.

The soundscape consists of several layers of white noise, drones generated by an analogue synthesizer and induction-coil microphone recordings of the minute amounts of static electricity emitted from computer monitors, television screens and electronic signs. This generated the overall effect of immersion in an electrically-charged environment both through sound and the visual cues of the movie marque inspired motion graphics.

Two large speakers were set up at the rear of the exhibition space to project the sound directly into the space and several different volume levels were tested before deciding on a level that would create the desired ambience and not overwhelm visitors or direct attention away from the prints.

5.2.5 Augmented Reality Software
During the exhibition of *Triple Vision*, tablets with the CVD simulation and recolouring software developed for *Colour Blind Test* were available allowing those with typical colour sight to view what those with CVD were seeing, and those with CVD to gain an appreciation of what those with typical sight were seeing.

5.3 EXHIBITION
5.3.1 Hannah Maclure Centre Gallery
Eye for an Eye/Triple Blind were exhibited as part of *Eye for an Eye*, an exhibition of *Colour Blind Test, Eye for an Eye/Triple Blind* and supporting materials, at the Hannah Maclure Centre Gallery, Dundee Scotland, 28 Jun through 4 July 2014. It was attended by 718 people over its short run. The exhibition is more fully described in the previous chapter in 4.6.1.1 Hannah Maclure Centre Gallery.[3]

5.3.2 EVA London 2014
In the morning of 8 July, the paper Eye for an Eye was presented to the Electronic Visualization and the Arts (EVA) London conference. The paper outlined the art, science and initial experiments in the creation of the motion graphics and the simulation software for those with full colour vision and those with CVD.

The art and the software was demonstrated later in the day. An estimated 300 people attended the conference. The paper was published in the proceedings.

The work was well received with questions and comments revolving around two issues. First was the potential for the embedding the technology into the then topical Google Glass, the computer display integrated into eyeglasses. Second was the investigation of further research into potential applications outside of art. At the time, I did my best to respond to the comments and questions, but on reflection, both issues were outside of my interests as an artist. The issues raised were passed onto my collaborator
David Flatla.

5.2.6.3 Xihu Contemporary Art Gallery
From 22 September through 3 October, 2015, *Triple Vision* was exhibited at Xihu Contemporary Art Gallery, Hangzhou China as an edited two print/projection piece titled *Double Vision*. The exhibition was part of the IMPACT 9 international printmaking conference. Over 500 people attended the conference and the gallery was open to the public. At the conference, a paper entitled *Double Vison* was presented and published in its proceedings that outlined the development of the work. Although technical complications limited the availability of the art, the response to the art and the paper was valuable. The Ishihara inspired imagery proved wide-ranging, being recognized by many of the Chinese and international attendees, and issues concerning CVD and the effect it may have on perception were topics discussed at the conference.

5.4 Findings

In *Eye for an Eye/Triple Blind*, I applied an understanding of colour, motion, artistic principles, printmaking techniques and computer software to create animations that had certain elements apparent only to targeted audiences of specific visual abilities. Incorporating those animations into still, printed images created a unique artform.

During exhibition of the work and presentations of the papers, I fielded questions, observed audiences interacting with the work, and collected feedback through conversation. Audience queries and comments reinforced previous findings regarding the commonality of the Ishihara inspired imagery, curiosity about CVD, and interest in the manipulation of visual perception. The soundscape was generally appreciated, but not universally.

These observations support the theory that audiences with different visual acuities can be differentially engaged through creating works specifically designed to do so, and expand the media through which this engagement can be delivered to include animation and sound.

Adding the layered soundscape both expanded the repertoire of perceptual investigation and added further engagement to the projected work. This engagement was not intended to be overtly different for the two audiences, but did provide a means of creating an environment sympathetic to perceptual variances. The sound helped establish and environment of sensory perception.

An unexpected result of the work was its visual impact. The intensity of the colour contrasted against the black transformed both the prints and the projections into an experience that was more than the sum of the two parts. The colours appeared to be radiating from an internal source while the black became a void rather than a surface. The prints themselves, displayed on easels, became mysterious. They were not visible as prints, but only as groupings of changing and floating luminous dots inexplicably revealing and hiding themselves dependant on one's position in the dark room.

Importantly, in the exhibition of *Eye for An Eye* and *Triple Blind*, a new platform for expression was created, the projection mapped motion graphic print.

The manipulation of light rather than pigment was challenging and intriguing. The translation of colour between different colour modes, specifically CMYK and RGB was satisfactorily overcome, but it remains to be further explored. With the invaluable aid of David Flatla and Raz Ullah, I continued to explore perception through the intergeneration of projected light and printed graphics as described in Chapter 6.0

Notes

[1] This manual process was streamlined for later animations by the production of an RGB percentage table of red and greens that collapsed to the same browns. It was gleaned from the look-up-tables (LUTs) of substitution colours integrated into David Flatla's CVD simulation software.

[2] A gamut is the colours occupied or detected by a particular colour medium within the entire colour space. Cameras detect a certain gamut. CMYK colours have a slightly different gamut than RGB colours. Colours represented on a computer screen have a slightly different gamut than those form a colour projector. When moving between mediums gamut issues often arise.

[3] Of note, the soundscape was questioned by one attendee who doubted its relevance to the exhibition which was concerned with visual perception. Although I expressed the intention of creating an enveloping environment encouraging sensory perception, with the soundscape being an element of that, and the relationship between sound and image in other media such as television and cinema, he remained unpersuaded of its additional value.

References

Gilje, H. 2010. VTP. Available from: https://hcgilje.wordpress.com/vpt/ [Accessed 20, May 2017].

thekinolibrary. 2014. 1970s Drive Through Las Vegas at Nigh.t Available from: https://www.youtube.com/watch?v=5WDdZNqL7Ac&t=10s [Accessed 20 05 2015].

BALL OF CONFUSION

6.0 STUDY FIVE: BALL OF CONFUSION

Ball of Confusion is the last study of *Double Vision*. Continuing the collaboration between artists David Lyons, Raz Ullah and David Flatla, it is a multi-media interactive environment that integrates graphics, projected animations and a dynamic soundscape. It considers the questions: Can an artistic analogy to colour deficient vision be created that engages both those with CVD and the typically sighted? Can the addition of dynamic reactive sound enhance the experience? These questions were refinements considered within the ongoing investigation of the research questions: Can artwork be intentionally created to be experienced differently dependent on one's visual abilities? If so, can those experiences be shared?

Visually similar to an enlarged print of *Triple Vision* and relying on the assets created for *Eye for An Eye/Triple Vision*, *Ball of Confusion* furthers the perceptual exploration research aims of those previous works through sight and sound. The study takes an innovative approach, creating an interactive parallel to colour and colour deficient vision enhanced through dynamic reactive sound.

The piece consists of a 200 X 200 cm black screen occupied by a large circle of white dots. A full-colour motion graphic is mapped to those white dots through being projected from three separate projectors, one with a red filter over the lens, the second with a green filter and the third with a blue filter. Because each of RGB channel is being projected from a distinct projector, audience members can obstruct one or two of the

channels without affecting the remaining channels. Those obstructions prevent that colour reaching the screen but do not interfere with the other colours reaching it. This allows for full-colour interactive shapes and forms to be created where black shadows would be expected.

6.1 BACKGROUND

Ball of Confusion continues the shared experimental enquiries researched through exploring the theme of simultaneous engagement of audiences with varied colour vision acuities, by specifically allowing viewers to interact directly with the piece and affect the image representation and perception.

The relationship between how colour is created and how the eye processes those colours is the foundation of visual perception. The exploration of this connection gave conceptual insight into the fundamental functioning of the perceptual experiences of the previous studies.

A soundscape integrated into the work fills the environment with music directly affected by audience interaction with the projected motion graphic. Sound occupies the three-dimensional space of the environment, integrating the two-dimensional projection into the setting and disseminating the audience engagement.

The study also further explores the intense visual impact of projected colours onto white reflective surfaces contrasted and defined by a flat black background, a key finding of the previous study.

6.1.1 The Human Eye Analogy

The way we perceive colour and the way colour is constructed have important similarities. Additive colour, the mixing of three coloured lights to produce a full range of colours, is the name of the colour theory that describes how the colours used for the projections in this study were created.

By using three different projectors to create the motion graphic, and the possibility of changes in the colours of the motion graphic through the interaction of viewers, the artwork becomes a representation of colour and colour deficient vision.

Since the discovery of how the eye perceives colour and how colours are created and they have been understood analogously. Thomas Young and Hermann von Helmholtz, in the 19th century, discovered how the eye perceives colour. The human eye has colour receptors called cones (described in greater detail in 4.1.3.1). There are three different types of cones, one that detects primarily blues, one that detects primarily greens, and one that detects primarily reds (although there is significant overlap of the range of colour detected by each type of cone). Shortly thereafter, inspired by the Young–Helmholtz theory, James Clerk Maxwell applied some of those findings to the creation of colour rather than the perception of it, creating a

full-colour photographic projection of a tartan by combining red, green and blue filtered slides of that tartan (Young 1802) (Tolstoy 1982).

Ball of Confusion uses the similarities between colour creation and colour perception to illustrate the effects of CVD on colour perception. In CVD, one set of cones, either blue, green or red is missing or malfunctions, affecting colour perception. With the projected motion graphic, interference to the light emitted from one of the projectors filtered red, green or blue, affects the colours that can be perceived.

6.1.2 The Soundscape

The reactive soundscape of *Ball of Confusion* filled the large (roughly ten square metres) open environment required for audience interaction with the projections. Much of that interaction was visualized on a two-dimensional screen on one wall. By continuously occupying that three-dimensional space and by emphasising audience interaction, the soundscape created a sense of environment relatable to a cinema, where direct perceptual connections are made by the projected film and the soundtrack. Through light sensors controlling the soundscape, the audience of *Ball of Confusion* has a direct effect on both the images and sounds creating a unified experience.

Figure 6.1 A 200 x 200 cm flat black vinyl screen was cut to specification and applied to a white wall.

6.2 BUILDING THE ART

6.2.1 The Screen

A 200 x 200 cm piece of flat black vinyl was commercially cut to specifications derived from an enlarged version of the black and white *Triple Vision* print. The cut-out circles were discarded leaving a black background dotted with empty circles. The vinyl was then adhered to a white wall to serve as

a background screen for motion graphic projections. The wall outwith the vinyl was painted flat black resulting in a large black wall with 200 cm white dotted version of the Ishihara inspired imagery in the centre (Figure 6.1).

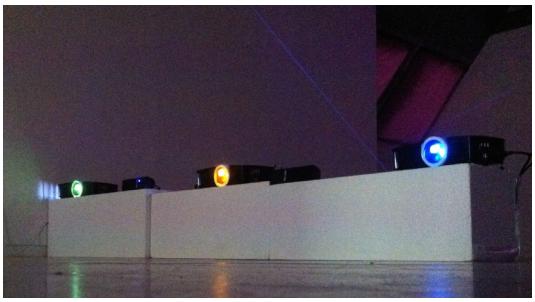


Figure 6.2 The projectors in the gallery

6.2.2 Motion Graphics

The motion graphics comprised the three animations developed for *Eye for An Eye* edited into one continuous looping video. The video was split into three identical feeds, each of which led to a different projector. The three projectors were placed at a distance of 150 cm from each other but pointed at the black vinyl screen (figure 6.2). The distance between the projectors was limited by the available space in the gallery.[1] Each projector was filtered by either a red, green or blue lighting gel filter, creating three distinct projections analogous to the wavelengths of light detected by the blue, green and red cones of the human eye. Those distinct projections were re-combined through projection mapping (see 5.2.3) resulting in a full-colour motion graphic that is identical to the original unfiltered motion graphic.

6.2.3 The Soundscape

The soundscape was created using a virtual instrument within music production software Ableton Live. The C minor 7th chord (notes: CEGB) was used in four iterations:

1. Chord held continuously to create a drone
2. Chord played as a 1/16th note arpeggio
3. Chord played as a 1/8th note arpeggio
4. Chord played as a 1/32nd note arpeggio

The structure of the soundscape was as follows:

16 bars chord drone

16 bars chord drone + 1/16th arpeggio

16 bars counter melody + 1/8th and 1/32nd arpeggios. This was looped continuously.

The sound file playing off a laptop was connected to two speakers placed either side of the projectors to project the sound into the 'interactive area'.
The changing sections of the soundscape from quarter notes, eighth notes and sixteenth notes were influenced by changes in the installation's immediate colour environment. Those changes were triggered by audience interactions with the projected image, detected by camera sensors and projectors within the installation setting.

6.2.4 The Interference
In *Ball of Confusion*, individual channels of filtered projected light could be obstructed. This interference changed both the projected image and the soundscape. The greater that interference, the more radical the change to the immediate environment.

6.2.4.1 Visual Interference
The effect of the positional interference on what was visible was directly mediated by the proportions of light blocked from each of the Red, Blue and Green filtered projectors. An obstruction blocking only one of the projections interfered with that colour reaching the screen without affecting the other colours reaching the screen. This allowed for shifted colour interactive shapes and forms to be created where black shadows might be expected.

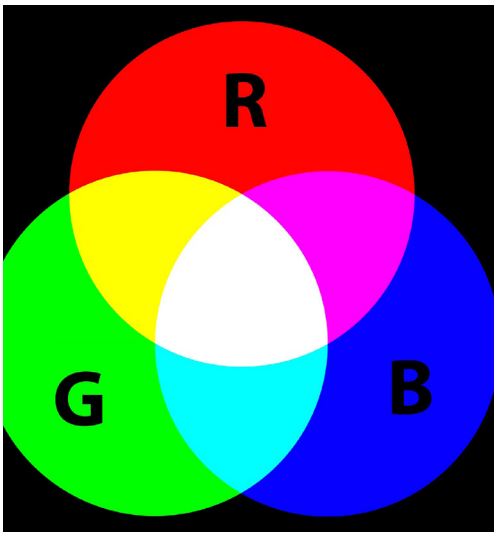


Figure 6.3 All additive colours can be made by varying the of red, green or blue projected. When red, green and blue are present in equal amounts the colour is white.

Just as in a TV or computer monitor, the projections were made up of the combination of three colours; red, green and blue (RGB). All additive colours, as discussed in 4.1.3.3 CIE Color Space Model, are made by varying the amount of red, green or blue projected. When red, green

and blue are present in equal amounts the colour is white (Figure 6.3). The absence of all of the colours is black. Equal amounts of red and green, but no blue, produce yellow. Green and blue, without red, produce cyan. And, blue and red, in the absence of green, produce magenta.

The interference to one or more of the lights from the red, green and blue filtered projectors would cause that colour to be absent in the projection, shifting the motion graphic colour accordingly.

6.2.4.2 Soundscape Interference

A webcam pointed at the art was connected to the laptop computer and responsible for producing the soundscape. The system for detecting interaction was created in MAX/MSP – a suite of tools for sound, graphics and interactivity. The specific module within the software used was 'jit.brcosa', which reads brightness, contrast and saturation on pixel data. Particular speeds and pitches were assigned to a parameter defined by the original motion graphic pixel brightness, contrast and saturation. By sending webcam information (via USB) to this module it was possible to read values for the brightness, contrast and saturation, and then send them to a sound file player to affect the playback behavior of the sound file. In the absence of any interference the sound file played normally with no variations in speed/ pitch. If variations were detected, the speed and pitch at which the file was played would change according the amount of disruption the original motion graphic's parameters.

With no interaction in the space the values remained static, however when somebody entered the field of vision of the webcam the values changed and these changes then directly affected the playback speed and therefore the pitch of the sound file. With a large number of participants in the space these changes were exaggerated and the sound file jumped rapidly between different speeds. With fewer participants these speed changes were less pronounced.

6.3 EXHIBITION

Ball of Confusion was shown in the *Double Vision* exhibition. Part of *Print Festival Scotland*, the exhibition was held at Centre Space, the gallery of the Visual Research Centre of Duncan of Jordanstone College of Art and Design, Dundee Scotland 1 July – 5 July 2015. *Ball of Confusion* was accompanied by the twelve prints of *Double Blind Test Series*, the motion graphic media tests from *Eye for an Eye*, and *Colour Blind Test* with its accompanying computers loaded with CVD simulation and recolouring software. An estimated 100 people attended the show.

By design, as people moved through the exhibition space, they were the cause of the positional interference in *Ball Of Confusion* (figure 6.4).

Audience Reaction

Audience reaction to specific research driven aspects of the exhibition was gauged through use of an anonymous printed survey made available at the show's opening and, where possible, through unstructured conversation. All survey responses are included in the appendices, but questions 6, 7 and 8 are considered here as they directly relate to *Ball of Confusion*. 14 people completed the survey out of approximately 70 opening attendees; giving a response rate of 1 in 5. 86% of the respondents interacted with the projected elements of *Ball of Confusion* and 72% were at least partly persuaded that the interaction helped them understand how others might see the work, and the world, differently. One respondent made the overall comment: "Interactive piece particularly expressive"

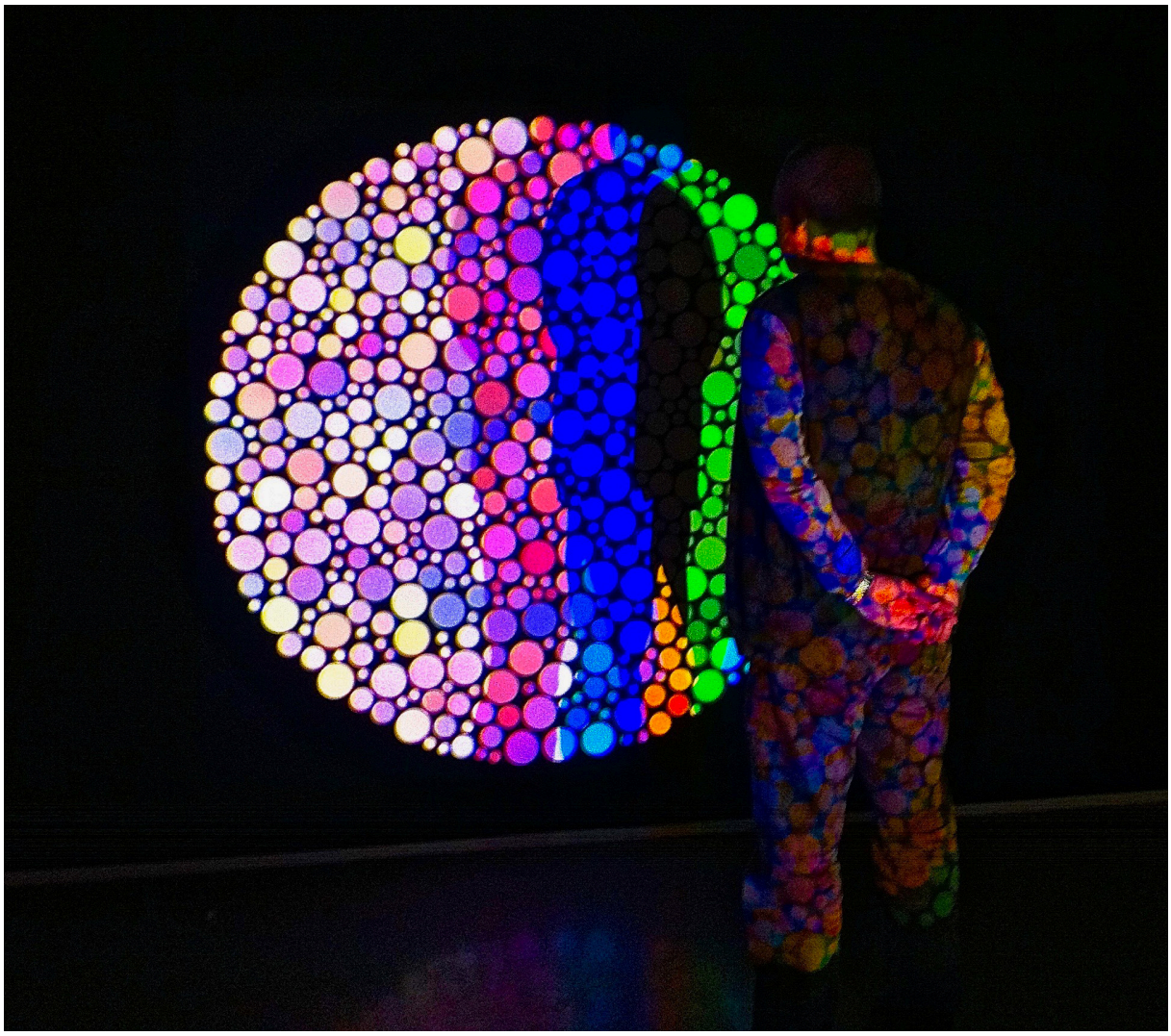


Figure 6.4 Audience member interacting with Ball Of Confusion

Impressions from the soundscape element were less well formed. 57% of the respondents reported that they interacted with it. Some queried its fit, with comments such as "The soundscape is intriguing, but how does it relate 'conceptually,'" and "It was hard to tell if it changes in sound initially, as the soundscape changes anyway".

Conversations regarding the work were uniformly positive. Of note were comments on the exhibition as a whole. It was the first time all the work was shown together and comments on the effectiveness of the communication of perceptual variation was noted. A twice repeated phrase was the effectiveness of 'variations on a theme'. One attendee with CVD, who had attended a pervious exhibit of the work, commented on the 'full circle' the work had taken moving from appropriating the test for CVD, then creating art targeting those with CVD to creating an interactive 'metaphor' for CVD.

Question Response:	Yes	Maybe	No
6. Did you interact with the projected piece?	86% (12)	N/A	14% (2)
Comments: Bloody FAB! Moving within the space, getting close to the screen.			
7. Did you interact with the soundscape?	57% (8)	N/A	14% (2)
Comments: Didn't know you could. The soundscape is intriguing but how does it relate 'conceptually'?.			
8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?	44% (6)	28% (4)	28% (4)
Comments: After this question I started to think about this I found the soundscape most effective when interacting at close range of the projectors. It was hard to tell if it changes in sound initially as the soundscape changes anyway.			

[Percentages are rounded to equal 100%. (#) = Number of responses]

6.4 FINDINGS

Ball of Confusion asks: "*Can an artistic analogy to colour deficient vision be created that engages both those with CVD and the typically sighted?* From observations, conversations and survey responses gathered at the *Double Vision* premier of *Ball of Confusion*, the answer is yes. The installation engaged both sighted and those with CVD as evidenced in the level of audience interaction and acknowledged in the positive comments on perceptual variation and expression.

Secondly, *Ball of Confusion* successfully realised the ambition to create an analogous representation of the causes and effects of colour vision. Audience interaction with the projected light resulted in changes of the projected motion

graphic in ways comparable to the effects of malfunctioning cones of the eye, particularly red-green CVD. Interfering with the motion graphic by impeding the light emitted by the red filtered projector suggests the effects of protanopia. Blocking with the light from the green filtered projector suggests deuteranopia. Blocking the light from the blue filtered projector is akin to tritanopia.[2] While the audience was not universally aware of the analogy in play, it was intended to have such conceptual metaphors for visual experience and enjoyment, and not necessarily for intellectual exercises. If explicit appreciation of the analogy was required in future exhibitions, additional means of illumination, such as accompanying literature, could be added.

A third finding expands on the theme of perception. Shadows lighter in colour than their surroundings create an experience that directly challenges one's perception. The effectiveness of this technique calls for further exploration.

A fourth finding is that the soundscape helped to create an immersive environment resulting in a three-dimensional interactive space. But the subtle modulations of sound created by audience interaction with the visual work may have made that connection ambiguous. Further investigation and refinement are required to fully integrate the visual and audial experiences.

Notes

[1] To a point, the greater the distance between each projector the higher the chance that only one projection will be interfered with thus providing optimum opportunities for interaction with the motion graphic.

[2] Because the brain of tritans interprets the medium wavelength greens as blues the projections do not give a comparable visual representation.

References

Young, T. 1802. *The Bakerian Lecture: On the Theory of Light and Colours.* Available from http://rstl.royalsocietypublishing.org/content/92/12.full.pdf+html [Accessed 20 May 2017].

Tolstoy, I. 1982. *James Clerk Maxwell: A Biography.* Chicago, University of Chicago.

Discussion and Conclusion

7.1 AFFIRMATION NOT EXHAUSTION

At its outset, this research proposed to use principles of graphic design to expand the tactile vocabulary of Braille. However, early user-based research informed that this was an unwanted and/or unneeded solution. The limitations of *Graphic Design for the Blind* led to the development of a productive line of investigation. Although the original hypothesis was rejected, there was new knowledge about the visual preferences of partially-sighted audiences and an underlying theme of perception began to emerge.

The use of design principles remained a feature throughout, both in terms of user research and testing, and use of design motifs from Braille and the Ishihara imagery. The use of these elements signalled the intent of the art, and their global recognition was exemplified by the response of the Hangzhou audience to *Triple Vision*. The infra-signal contextualisation of the Ishihara imagery proved to work inter-culturally here. In execution and reception, Double Vision occupies a niche at the intersection of art and design.

Double Blind Test Series addressed perception through exploration of visual acuities. Blindness, myopia and hyperopia were explored through the use of Braille, varying text sizes and colour ranges. The absence of colour was also employed, through including colourless varnished text which appeared and disappeared depending on the viewer's physical position to it. This simultaneous presence and absence of text further signified a subtext of duality interrogation.

While the *Ishihara Test* formed the visual foundation for *Double Blind Test Series*, CVD was directly addressed in only one of the twelve prints. Recognising the possibilities of this visual variance for the embedding of specific messages to particular visual acuities led to a more thorough examination in *Colour Blind Test.* Understanding how the eye works for those with normal and colour deficient vision was key to advancing this work. From the intent of designing art with specific and distinct messages embedded for different audiences arose the possibility of exploring how what is seen influences what is understood. And further, if what is seen is changed, does this also change what is understood?

Colour Blind Test sought to address these questions through the embedding of hidden messages, and their revelation to different audiences through the use of colour-correcting software. In tests using the same image, very different messages were delivered to targeted groups. One group saw the word 'SHEEP', another the word 'heaven'. In the art, in the same print, one targeted group perceived horizontal lines, the other vertical. While these different messages were revealed to both groups through the use of digital devices, it was hoped that the impact of those very different perceptions would remain.

In *Eye for an Eye*, theories about vision and perception were further tested with the introduction of motion. With perception at the core of investigations, and as we do not live in in a world comprised of stagnant images, it was important to test the findings of *Colour Blind Test* in the context of movement. Such manipulations of visual perception are often viewed as 'optical illusions' and dismissed as trickery or manipulation. But it was reasoned that by embedding *Colour Blind's* learnings in motion, and later, as with *Triple Vision* and *Ball of Confusion*, in environments, serious audience contemplation of the supremacy of one's own perceptions might be triggered.

Increased awareness of differing perceptions and reflection on one's own perceptions were confirmed by responses to the *Double Vision* exhibition questionnaire. Written replies included:

> "Gives a very good idea how others see things."
> "Really liked the theme of perception being down to the individual."
> "With your thoughts you make the world' (See appendices).

These works also included an audio element. The original rationale was to create an immersive environment that would both draw visitors into the space and heighten their interaction with the prints.

On reflection, and based on audience feedback, the audio element somewhat confounded the interrogation of vision influenced perception. However, as this work was not created to answer a scientific question but to be an immersive artistic expression, to that end the addition of sound was deemed successful.

Production of *Eye for an Eye* necessitated a more thorough understanding of the relationship of wavelengths that each cone detects and how that translates to colour theory and colour space models. Along with that also came with greater understanding about how colour is reproduced, both as subtractive (CMYK) and additive (RGB) approaches in *Triple Vision.*

In *Triple Vision*, learnings from much of the preceding work reach their apotheosis. The colour grouping preference of visually impaired (from chapter 4.0 findings) is exemplified in the intense contrast and saturation generated by the projections onto prints. Also, the innovation of motion graphic and print integration is of continuing interest.

The last study, *Ball of Confusion*, resembles *Triple Vision* at first glance, but also operates as an analogy for how those messages are embedded to those with CVD. By blocking any one projector, a viewer creates a visual effect similar to a non-functioning cone in CVD. Interrupting the light from the red filtered projected is analogous to deuteranopia. Blocking the red-filtered projector; protanopia. And, blocking the blue; tritanopia.

Each study, with the exception of the first, concluded with its affirmation, not its exhaustion.

7.2 CENTRAL THEMES

The studies are bound by several themes.

As a concept expressing both artistic and investigative intent, indivisible visual expression and theory were important. For me, that happened with *Ball of Confusion.* The novel use of projected colour motion graphics, the imagery, the audience interaction and the effect on perception satisfied an underlying but unspecified need for harmony. It was the achievement of that expression that lead to the awareness of completion. In *Ball of Confusion*, intentionally creating artwork to be experienced differently dependent on one's visual abilities was achieved, but here, the mode of conveyance required direct viewer intervention thus creating the situation where they became active in forming what was to perceived and understood. In doing so, the art moved beyond targeting those with, or without, CVD and towards investigation into the foundations of colour and colour perception

Throughout *Double Vision*, the *Ishihara* imagery was a defining aspect. Used as an indicator of the topic of CVD, it helped reveal that there were hidden messages within the work directed at people who saw the world a bit differently than others. But, while the Ishihara imagery was instrumental in conveying context in much of the work in Double Vision, the effective use of projected light warrants future investigation unhindered by the connotations of that imagery. The successful meeting of the aims signalled the conclusion of the *Double Vision* investigation and

the move away from the Ishihara imagery. Drawing to conclusion significant aspects of *Double Vision, Ball of Confusion* concurrently signalled new lines of investigation.

David Bowie said that the meaning of art "is not necessarily that implied by the author, there is no authoritative active voice. There are only multiple readings" (Price 2013. Accessed online). Once it is exhibited, the work is its own. It is the "thing-in-itself" or the "noumena". We gather information about it through our senses. Or, stated differently, we perceive the phenomena. We try to understand it.

The work of *Double Vision* was instilled with certain characteristics through the application of art and design principles and practice in the hopes of guiding its perception, concentrating on the sense of sight, with the addition of sound in later work (with the earliest work being through touch).

My aim was to produce art to be experienced differently dependent on one's visual abilities. Working within Arnheim's postulate that 'seeing is thinking' my intention was to not only create the work, but to embed information to be perceived. Using the physiology of the eye, an understanding of colour theory and application of the principles and fundamentals of art and design, I attempted to direct not only how one views the work, but to tailor the work to how one physically sees it in the hopes of directly influencing the 'thinking in seeing'.

Additionally, I applied design strategies. Identifying specific audiences to target, I iterated solutions and tested them with those audiences. I sought input from others and worked in collaboration towards dynamic solutions that I could not as effectively create on my own. And to underline the work's intent, literary references to perception taken from Blake, Huxley and Wolfe were embedded into the art. But it was not until *Ball of Confusion* that audience members had a direct influence on the work and their perception of it. In previous work, perception was a passive theme that was implicit in the work. With *Ball of Confusion* the audience interaction became an explicit manifestation of variations on perception. Actions directly influenced perception. The audience helped create that which they perceived.

The exploration of dualism played an important role in the studies of *Double Vision*. Within pieces from *Double Blind Test Series, Colour Blind Test,* and *Eye for and Eye/ Triple Vision* dualism was explored through subject matter, text, audiences, and colour.

As a way of understanding the world, dualism has been used by religion, philosophy and psychology. St Thomas Aquinas' division of the body and soul and the other dualisms present in Christianity, such as good and evil, heaven and hell and sheep and goats played an obvious role. The text and the titles of *Colour Blind Test* are direct references. The direction of lines and chevrons are intended to contradict their conceptions.

Philosophically, Cartesian dualism makes the distinction between the body and the mind. “I think, therefore I am” as Descartes put it. Psychology can have a similar division, separating seeing and thinking. The senses are providers of raw information that the brain then processes (Lieberman 2012).

Descartes’s dualism relies on perception. The body provides information for the mind to comprehend. If man only assents to what he clearly perceives his thinking will be error free. (Garvey and Stangroom 2013). Images created for *Double Vision* challenge the notion of clear perception and thus, also the foundation of Cartesian dualism.

The examination of duality in terms of perception was aided by the questioning of the Christian ‘good and evil’ found in Blake’s *Marriage of Heaven and Hell*, Huxley’s drug fuelled examination of the effect of seeing and thinking on reality in *Doors of Perception/Heaven and Hell*, and Wolfe’s chronicling alternate psychedelic culture in *The Electric Kool-aid Acid Test*. They showed a thing did not have to be defined by its antithesis but could exist alongside, in parallel or alternatively, as exemplified by the lust of the goat for Blake or seeing music as described by Wolfe.

Dualism was explored through representing inherent contradictions. Resolution to those contractions was not the intent. Consequently, its exploration ended with the work’s progressive coherence and unity.

But, what of meaning? Does a world seen differently have different meanings?

Double Blind addresses meaning though art. It incorporates methods that people use to give meaning to the world; art, music, literature, philosophy, religion and drugs. It uses techniques to vary meaning from one person to the next though enigmatic titles, varnish printed text, varying point sizes and rotating text.

Meaning and perception are intertwined (Merleau-Ponty 2004). Regarding vision, a question arises: if one perceives different colours than another, does this alter meaning? The philosopher Martin Lipman, from the University of Amsterdam, addresses this question in his essay, Fewer Looks or Alien Looks, written about his attendance at my *Eye for an Eye* and *Double Vision* exhibitions (see appendices).

Lipman explains that there are two philosophical camps on this question, the Reduction View and the Alien View. The Reduction View poses that those with red-green CVD, for example, see the world the same as those with typical sight but cannot distinguish between red and green.

The Alien View suggests that those with the red-green CVD see the world differently than the typically sighted. It is constructed through one’s available vision. This is

Figure 7.1 Dandelion on right as typically seen, and on the left photographed to expose an ultraviolet pattern.

analogous to my visual perception of a flower, compared to that of the ultra violet sight

of a bee. The bee's perception of that same flower is 'alien' to mine (Figure 7.1).

But, appearance is only a glimpse of the significance of differing perception. Concerning the Heaven and Hell prints from Colour Blind Test, Lipman, who has red-green CVD, argues for the Alien View. He Writes:

> …the prints remind us: seeing different colours can sometimes mean seeing different patterns, different shapes, different messages. We live our lives on the assumption of inhabiting a shared world. But in the company of these prints, this assumption of a fully public, transparent world seems a comfortable illusion, naïve. The colours things appear to have around us directly influences the way we feel and respond, and things appear to have radically different colours to different people… The hidden messages remind us of just how much can be in appearances lying beyond our reach. The differences in the way things look on the prints… remind us of the true and deeper alienation arising through our potentially incommensurable perspectives on the world.

Lipman's views are supported by other feedback from the Double Vision exhibition. From a written survey response: "...the idea of different people being able to experience it differently from myself is intriguing". The work challenges the familiar and normal, ultimately leading to the questions 'what

is known'. To me, surprisingly Descartes helps here. As he describes, there are physical objects and the immaterial mind. I know I exist. But, I am not so sure about you.

7.3 RESULTS

Double Vision was research led by artistic practice. Its creation was informed by science.

Art that is informed by science is not a slave to science, notes Herbert Read (Read 1964). Nor should it be a slave to aims, questions, theories or philosophies. *Double Vision* was allowed to evolve, charting its own course. The aims and questions were changed and modified to support that evolution. Science, aesthetic theories and philosophies were tools used in the work's creation. They were sought out by the needs of the work. The work was not created for their needs.

Artistic and design methods were employed. Personal aesthetics and preferences determined choices. Potential solutions were tested for the desired effects using software modified for that purpose and targeted at specific audiences. Those solutions were assessed and iterated until the desired results were achieved.

As artistic practice, *Double Vision* was a success. A substantial interrelated and progressive body of work was created and exhibited at multiple stages of its development. It drew and engaged audiences, to the point of collaboration and a written essay on the philosophical implications of the work (sections 4.0 and 4.6.3.2).

Double Vision advances an understanding of vision's influence on perception and how it impacts our interactions with others and interpretation of the world. It answered the questions: *"can artwork can be intentionally created to be experienced differently dependent on one's visual abilities?"* and *"If so, can those experiences be shared?"* through creating 5 studies of works and verifying their effect through test groups (section 4.2.5.3), questionnaires (6.3.1), observation and conversation (4.6, 5.3, 6.3).

In advancing this understanding, *Double Vision* also resulted in new tools, approaches, process, techniques and mediums being developed and documented. *Double Vision* initiated innovations in CVD Colour grouping, CVD embedded messages, CVD Simulation and Recolouring software, interactive projection mapped motion graphic prints through RGB-split projections. It moved imagery from two-dimensional representations to animations, integrated animations into prints and then onto an interactive environment. It interpreted visual imagery through sound and then tied that sound to colour.

Art is logical, writes Theodor W. Adorno (Adorno 1997). The aims of this project and their successful outcomes were dependant on the logic of artistic practice. Applying an understanding of the science behind the colour detecting mechanisms of the eye, and its application to a three-dimensional colour space model was driven by the artistic capability essential for the progress of this project. Moreover, the success of the aims was dependent on artistic notions such as warm and cool colours and visual groupings.

Successive iterations and variations of the work led to deeper understanding and progressive investigations. The compounding effect was research that moved far from an initial interrogation of tactile typography to a conclusion of creating new understandings of seeing, novel art and art forms and computer programs that aid in inclusiveness.

Double Vision describes a journey from creating art to be differentially experienced by those with CVD, to delivering an artistic analogy of CVD that can be similarly experienced by all.

If Adorno is right and art is logic, this is the logical place to end.

References

Adorno, Theodor W. 1997. Aesthetic Theory. New York, Bloomsbury.

Garvey, J and Strngroom, J. 2013. The Story of Philosophy: A History of Western Thought. London, Quercus Editions Ltd.

Lieberman, D. 2012. Social Brain, Social Mind, Psychology Today, May 2015.

Merleau-Ponty, M. 2004. The World of Perception. Abingdon, Routledge.

Price, S. 2013. David Bowie IS: The First Review, The Quietus. Available from: http://thequietus.com/articles/11682-david-bowie-victoria-and-albert-museum-exhibition"/ [Accessed 20 May 2017].

Read. H. 1963. To Hell with Culture. London, Routledge.

BIBLIOGRAPHY

Adorno, Theodor W. *Aesthetic Theory*. New York, Bloomsbury 1997.

Arnheim, Rudolf. *Art and Visual Perception: A Psychology of the Creative Eye*. Berkeley, University of California Press, second ed. 2004.

Arnheim, Rudolf. *Entropy and Art: An Essay on Order and Disorder*. Berkeley, University of California Press, 1971.

Arnheim, Rudolf. *Revealing Vision*. Ann Arbor, University of Michigan Press 1997.

Arnheim, Rudolf. *Visual Thinking*. Berkeley, University of California Press, 1969.

Baines, Phil and Dixon, Catherine. *Signs: Lettering and the Environment.* London, Laurence King Publishing LTD, 2003

Berger, John. *Ways of Seeing*. London Penguin, 1972

Barnouw, Erik. *Tube of Plenty: The Evolution of American Television*. 2nd ed. New York, Oxford University Press, 1990.

Blake, William. *The Marriage of Heaven and Hell*. Copy D, 1795 (http://www.blakearchive.org/copy/mhh.d?descId=mhh.d.illbk.03)

Campbell, Joseph. *The Power of Myth with Bill Moyers*. New York, Doubleday, 1988.

Campbell, Joseph. *The Symbol without Meaning*, Kindle Edition, Kentfield CA, Joseph Campbell Foundation, 2012

Frankfurt, Harry G. *On Bullshit.* New Jersey, Princeton University Press, 2005.

Garvey, James and Stangroom, Jeremy. *The Story of Philosophy: A History of Western Thought.* London, Quercus Editions, 2013.

Gilchrist, Alexander. *The Life of William Blake*. London, The Bodley Head, 1907.

Havinden, Ashley. *Advertising and the Artist.* Edinburgh, the Trustees of the National Galleries of Scotland, 2004.

Huxley, Aldous. *The Art of Seeing.* London, Chatto and Windus, 1943

Huxley, Aldous. *The Doors of Perception: And Heaven and Hell*, Kindle Edition. New York, Vintage Digital; New edition, 2010.

Ishihara, S. *Test for Colour Deficiency 38 Plate Edition*. Tokyo, Hongo Harukicho, 1917.

Kemp, Martin. *The Science of Art: Optical themes in Western Art from Brunelleschi to Seurat*. New Haven, Yale University Press, 1990.

Lattin, Don. *The Harvard Psychedelic Club: How Timothy Leary, Ram Dass, Huston Smith, and Andrew Weil Killed the Fifties and Ushered in a New Age for America*, Kindle Edition. San Francisco, HarperOne Reprint edition, 2009

Levi-Strauss, Claude. The Savage Mind. Paris, Libairie Plon, 1962. Reprint, Oxford: Oxford Press, 2004.

Livingstone, Margaret. *Vision and Art: The Biology of Seeing*. New York, Harry N. Abrams, 2002.

Lois, George. *The Art of Advertising: George Lois on Mass Communication*. New York, Harry N. Abrams, 1977.

Marcade, Jean-Claude. *Malevich, Painting and Writing: On the Development of a Suprematist Philosophy (Kazimir Malevich: Suprematism)* Kindle Edition, New York, Guggenheim Museum, 2012

Merleau-Ponty, Maurice. *The World of Perception*. Abingdon, Routledge, 2004.

Modley, Rudolf. *Handbook of Pictorial Symbols*. New York, Dover Publications, Inc., 1976.

Neurath, Otto. *International Picture Language*. London, Kegan Paul, Trench, Trubner and Co., LTD. 1936.

Petrova, Evgenia. *Malevich's Suprematism and Religion (Kazimir Malevich: Suprematism)*, Kindle Edition, New York, Guggenheim Museum, 2012

Read, Herbert. *The Meaning of Art*. Bungay, Pelican, 1950

Read, Herbert. *The Philosophy of Modern Art*. London, Faber and Faber, 1964.

Read. Herbert. *To Hell with Culture*. London, Routledge, 1963.

Sacks, O. *An Anthropologist on Mars: Seven Paradoxical Tales*. Alfred A. Knopf,

USA. 1995.
Spiekermann, Erik. *Rhyme and Reason: A typographic Novel.* Berlin,
H. Berthold AG, 1987.

Tuchman, Maurice and Judi Freeman, eds. *The Spiritual in Art: Abstract Painting 1890-1985*. New York, Abberville Press, 1986.

Tolstoy, Ivan. *James Clerk Maxwell: A Biography*. Chicago, University of Chicago, 1982.

Wolfe, Tom. *The Electric Kool-Aid Acid Test*, New York Macmillan, 1966.

DISCOGRAPHY

Cake. 1998. Satan is My Motor. *Prolong the Magic*, Capricorn.

Cake. 1998. Sheep Go To Heaven, *Cake, Prolong the Magic*, Capricorn
.
Talking Heads. 1979. Drugs, *Fear of Music*. Sire.

Talking Heads. 1979. Heaven. *Fear of Music*. Sire.

The Temptations. 1970. *Ball of Confusion*, Gordy.

Ulver. 1998. *Themes from William Blake's The Marriage of Heaven and Hell*, Jester.

APPENDICES

WEB LINKS

DOUBLE VISION WEBSITE
davidlyonsdesign.wordpress.com

EVENTS
Field of Vision Panel Discussion, Dare to be Digital, 2013 Dundee Scotland
Video: https://youtu.be/n0kV2teil04
Announcement: http://archive.daretobedigital.com/259_DareProtoPlay-2013.html

Seeing Double: The Colour Blind Test Series, Dundee Arts Café, McManus Gallery Dundee Scotland, 03 02 2015
Announcement: https://www.dundeeartscafe.co.uk/category/pastevents/page/2/

EXHIBITIONS
Eye for An Eye, Generation: 25 Years of Contemporary Art in Scotland, Hannah Maclure Gallery, Dundee Scotland
https://www.abertay.ac.uk/media/generation%20dundee%20leaflet%202014.pdf

Impressions: Juried Printmaking Exhibition. Montgomery College, Rockville MD USA 05 02 2014
Announcement: http://insidemc.montgomerycollege.edu/details.php?id=51179

Double Blind Test Series. Hannah Maclure Centre Gallery, Dundee Scotland 26 07 2013
Announcement: https://www.abertay.ac.uk/discover/news/news-archive/2013/name-26876-en.php

DOCUMENTARIES
David Lyons: Eye for an Eye, Summerhall TV/Art in Scotland TV 10 07 2014
Video: http://www.artinscotland.tv/2014/david-lyons-eye-for-an-eye/

Blind Art for The Sighted, Abertay TV 26 08 2013
https://www.youtube.com/watch?v=DuqXZDoVAL8

JOURNAL ARTICLE
Printmaking Today, Texting Times, David Lyons. Vol 22 Winter 2013 Issue 88
http://www.cellopress.co.uk/celloweb/default.jsp?PageID=2

MEDIA COVERAGE
Double Blind Test Series BBC Radio Scotland 26 07 2013, p.m.
https://graphicdesignfortheblind.tumblr.com/post/64671942849/mrdavidlyons-double-blind-test-series-on-bbc
Double Blind Test Series, STV 07 2013

https://www.youtube.com/watch?v=Vfd-ocGS7eE

Double Blind Test Series, The Courier, 02 08 2013
http://www.pressreader.com/uk/the-courier-advertiser-fife-edition/20130802/282720519589693

Double Blind Test Series, Creative Dundee, 07 2013
http://creativedundee.com/2013/07/double-blind-test-series/

Braille Art Exhibition to Open at Abertay University, BBC News, 22 07 2013
http://www.bbc.co.uk/news/uk-scotland-tayside-central-23410320

CONFERENCE PRESENTATIONS
Impact 9, Printmaking in the Post-Print Age, 2015 Hangzhou China
impact9.caa.edu.cn/home/
Abstract: https://repository.abertay.ac.uk/jspui/handle/10373/2532
David Lyons, Raz Ullah and David R. Flatla

ABSTRACT
Double Vision: The integration of Printmaking and Motion Graphics through Video Mapping

Double Vision is a proof of concept collaboration between artists David Lyons and Raz Ullah, produced with the aid of software developed by computer scientist David Flatla. The aim of these artistic experimental pieces is to enhance the existing medium of Printmaking by using contemporary approaches and new and inclusive technologies that appeal to audiences of varied visual acuities'.

Double Vision consists of a set of black and white prints that, when combined with motion graphics that are spatially mapped onto their surface, create potent visual experiences for both colour blind and typically sighted audiences. Companion smart devices programmed with specially designed augmented reality software are provided to visually translate the experiences for these two audiences, thereby adding further levels of interaction.

PRINTS
The prints are 86 x 86 cm black and white screen prints based on imagery influenced by the Ishihara Colour Blind Test. Unlike the Ishihara plates, the prints themselves are void of colour and use black instead of white for the background/negative space (image 1).

MOTION GRAPHICS & PROJECTIONS
The computer generated motion graphics overlay a sequence of colours onto the white areas of the prints whilst increasing the intensity of the black regions to create

the impression of movement in the print. The chosen sequences of colours communicate different messages to colour blind and typically sighted viewers (image 2). Colour conversion tables were used to help determine and refine the colours used for each motion graphic.1 In conjunction, the developed smart device application allowed each audience to view the work as seen by the other.

The underlying concepts, imagery development, technology employed and the simulation software creation will be examined and discussed from artistic, technical and scientific positions. Responses to the art and software by the different audiences will be evaluated.

Notes:
1The conversion tables translate between colours seen by colour blind and typically sighted. They were developed and produced for the project by David Flatla.

EVA London 2014 (Electronic Visualisation in the Arts) London England
http://archive.eva-london.org/past-eva-londons/past-eva-londons/2014
Abstract: https://repository.abertay.ac.uk/jspui/handle/10373/2535

ABSTRACT
Eye for an Eye

Artist David Lyons and computer scientist David Flatla work collaboratively to create art that intentionally targets audiences of varying visual abilities mediated through smart device interfaces. Conceived as an investigation into theories and practices of visual perception, they explore the idea that artwork can be intentionally created to be experienced differently dependent on one's visual abilities. They have created motion graphics and supporting recolouring and colour vision deficiency (CVD) simulation software. Some of the motion graphics communicate details specifically to those with colour blindness/CVD by containing moving imagery only seen by those with CVD. Others will contain moving images that those with typical colour vision can experience but appear to be unchanging to people with CVD. All the artwork is revealed for both audiences through the use of specially programmed smart devices, fitted with augmented reality recolouring and CVD simulation software. The visual elements come from various sources, including the Ishihara Colour Blind Test, movie marques, and game shows. The software created reflects the perceptual capabilities of most individuals with reduced colour vision. The development of the simulation software and the motion graphic series are examined and discussed from both computer science and artistic positions.

Tenth IAWIS Triennial Conference, 2014 (International Association of Word and Image Studies), Dundee Scotland
https://iawis.org/tenth-iawis-triennial-conference/
Abstract: https://repository.abertay.ac.uk/jspui/handle/10373/2531

ABSTRACT
Colour Blind Test

Conceived as an investigation into theories and practices of visual perception, these prints explore the idea that artwork can be intentionally created to be experienced differently dependent on one's visual abilities. The software facilitates the embedding of messages revealed only to those with particular visual acuities or viewed using a smart device to digitally simulate those acuities.

Impact 8, Boards and Crossings: The Artist as Explorer, 2013 Dundee Scotland
http://www.conf.dundee.ac.uk/impact8/home/
Abstract: https://repository.abertay.ac.uk/jspui/handle/10373/2535

ABSTRACT
Double Blind Test Series

Braille is a communication tool in decline, in America by 80% since 1950, and in the UK to the extent that only 1% of blind people are now thought to read Braille.1, 2 There are a variety of causal factors, including the phasing out of Braille instruction due to the educational mainstreaming of blind children and the resistance to learning Braille by those who lose sight later in life.3 Braille is a writing system of raised dots that allows blind people to read and write tactilely. Each Braille character comprises a cell of six potentially raised dots, two dots across and three dots down. It is designed only to communicate the message and does not convey the tonality provided by visual fonts. However, in his book Design Meets Disability, Graham Pullin, observes that: “Braille is interesting and beautiful, as abstract visual and tactile decoration, intriguing and indecipherable to the non-reader ” and continues; “…braille could be decorative for sighted people.”4 I assert that the increasing abandonment of Braille frees it from its restrictive constraints, opening it to exploration and experimentation, and that this may result in Braille becoming dynamic expression for the sighted, as well as the partially sighted and blind. Printmaking is well suited for this exploration. Printmaking processes and techniques can result in prints aesthetically compelling to both senses of sight and touch. Established approaches, such as flocking, varnishes, puff-ink, embossing and die cut, combined with experiments in new techniques in laser cutting and 3D printing, create visually and texturally vibrant prints. In this paper I will detail my systematic investigation of sensually expressive printmaking concentrating on the issues surrounding Braille as a printmaking design element paying particular attention to the approaches and techniques used not only in producing its visual style but to those techniques used to keep it integrally tactile.

PAPERS

Eye for an Eye

EVA London 2014 Proceedings (Electronic Visualisation in the Arts) London England
http://www.bcs.org/upload/pdf/ewic_ev14_s3paper1.pdf
David Lyons and David Flatla

Artist David Lyons and computer scientist David Flatla work collaboratively to create art that intentionally targets audiences of varying visual abilities mediated through smart device interfaces. Conceived as an investigation into theories and practices of visual perception, they explore the idea that artwork can be intentionally created to be experienced differently dependent on one's visual abilities. They have created motion graphics and supporting recolouring and colour vision deficiency (CVD) simulation software. Some of the motion graphics communicate details specifically to those with colour blindness/CVD by containing moving imagery only seen by those with CVD. Others will contain moving images that those with typical colour vision can experience while appearing unchanging to people with CVD. All the artwork is revealed for both audiences through the use of specially programmed smart devices, fitted with the augmented reality recolouring and CVD simulation software. The visual elements come from various sources, including the Ishihara Colour Blind Test, movie marques, and game shows. The software created reflects the perceptual capabilities of most individuals with reduced colour vision. The development of the simulation software and the motion graphic series are examined and discussed from both computer science and artistic positions.

Colour perception, Motion graphics, Colour vision deficiency (CVD), Colour blindness, Mobile device

1. Introduction

Eye For An Eye is a continuing exploration of visual stimuli that aims to simultaneously engage audiences of varied colour vision acuities. Artist David Lyons and computer scientist David Flatla worked collaboratively to create art that intentionally targets audiences of varying visual abilities mediated through smart device interfaces. David Lyons is an artist interested in tools that might better help him create art that engages audiences of various sighted abilities. David Flatla is a computer scientist working with colour vision deficiency (CVD, also known as dichromacy or colloquially colour blindness) simulators and is interested in the artistic application his work might have.

Conceived as an investigation into theories and practices of visual perception, Eye For An Eye explores the idea that artwork can be intentionally created to be experienced differently, dependent on the viewer's visual abilities. The concept evolved from David Lyons' series of prints: The Double Blind Test Series (Lyons 2013). Visually and tactilely expressive, this series of 12 prints conveyed artistic intentions to the sighted, the blind, the colour blind, and the partially sighted. In Eye For An Eye, these ideas have been developed in collaboration with David Flatla to create a series of motion graphics for audiences with full colour vision as well as audiences with colour vision deficiency (CVD). Digital simulations, in real time on smart devices, will be used to share those differing experiences with audiences not typically able to view them.

This paper outlines the scientific work and initial experiments in the creation of these motion graphics and the simulation software for those with full colour vision and those with CVD.

1.1 Art and CVD

While art created specifically for those with CVD is uncommon, art created by those with CVD is not, and some has been very well received. Expressionist painter and printmaker Clifton Pugh had protanopia (Cole & Harris 2009). He was made Officer of the Order of Australia for service to Australian Art in 1985 (Australian Government 2014). As speculated by Japanese medical scientist Kazunori Asada, Vincent Van Gogh's vibrant use of colour was due to deuteranopia rather than Fauve influences (Asada 2011). In contrast, in *The Case of The Colorblind Painter*, Oliver Sacks chronicles an artist who gives up painting after losing his colour vision in a car accident. Because of the lack of colour, the artist found his art was without meaning (Sacks 1987).

The *Double Blind Test Series* of prints was based on the imagery, layout and colours of the Ishihara tests for colour blindness. *Anonymous Play* (Figure 1) from the series, strove to make the number six visible only to those with red-green CVD. When

exhibited, the print was positively received and drew those with CVD, including David Flatla, to the exhibition. A desire to refine this technique for creating differentially viewable artwork and to develop a body of art that can engage multiple audiences simultaneously led to Lyons collaborating with Flatla to develop CVD software simulation that specifically addressed his artistic requirements.

Figure 1: Anonymous Play, *from the Double Blind Test Series, 2013.*

2. THE CONCEPT

The pieces in Eye For An Eye also reference the circles of the Ishihara test, as well as the movie marque representations in the intro of The Rocky and Bullwinkle Show (The Bullwinkle Show 2011) and the stage set of the Gong Show (The Gong Show 2006). In movie marques, lights are turned on and off in a sequence to create the illusion of motion. The ambition with this work was to sequentially change the colours of the Ishihara circles to create the illusion of motion, and to manipulate the colours to create motion viewable differently for fully sighted and CVD audiences. The shared culture, accessibility and technology of mid-to-late twentieth century television and movies complements the accessibility and sharing of visual perception offered by the simulation software on smart devices. The use of the Ishihara imagery reminds the viewer that their visual experience of the work may be different than that of others. Unlike the movie marquee lights, the circles in the pieces do not turn on and off, but change colour instead. The viewer is neither included nor excluded depending on their colour acuity, but has a different experience because of it. The software allows those experiences to be shared.

Simulating how an image appears to someone with CVD allows people with typical colour vision to experience the image as though they had CVD. CVD causes a reduction in the number of colours perceived by an individual, such that colours that are distinct to people with typical colour vision are no longer distinct for people with CVD. For example, pink, grey, and turquoise are distinct colours for most people, but for those with protanopia (missing long-wavelength cones), certain varieties of these colours are not differentiable. To simulate the CVD-appearance of an image, the colours in the image must be replaced with colours that are perceived by someone with CVD. Techniques for determining how colours are replaced have been previously described (Meyers & Greenberg 1988, Brettel, Viénot & Mollon 1997, Flatla & Gutwin 2012), so we will describe the general approach briefly in terms of a simplified colour representation.

Colours can be conceptualised using a spatial representation in which individual colours occupy a unique location within the space. For the purposes of describing CVD simulation, consider an additive colour space defined by three orthogonal dimensions: a red-green axis, a blue-yellow axis, and a black-white axis. A colour's constituent amounts of redness or greenness, blueness or yellowness, and whiteness or blackness specify where the colour is located within this colour space. For example, red will be located at the red extreme of the red-green axis and in the middle of the blue-yellow and black-white axes. Medium grey is located in the middle of all three axes (placing it in the centre of the space). Purple is located at the blue extreme of the blue-yellow axis, the red extreme of the red-green axis, and near the middle of the black-white axis.

Deuteranopia and protanopia are colloquially called red-green colour blindness; people with these types of CVD have reduced ability to distinguish between greens and reds. In the colour space just described, these CVDs can be represented as the space collapsing along the red-green axis, such that all colours that lie on any line that is parallel to the red-green axis are represented by a single colour that lies on the plane defined by the blue-yellow and black-white axes. In the example given above, the pink, grey, and turquoise that are not differentiable for people with protanopia all lie along one of these lines, so are perceived as the same shade of grey.

3. THE TOOLS

3.1. Motion Graphics Creation Tools

Most of the stills for the imagery were initially created and tested in Adobe Illustrator. The colour tools in Illustrator were used to identify the RGB percentages for each colour used. The Color Blind Proof setting in the View menu was set to deuteranopia providing a simulation of CVD (it can also be set to simulate protanopia but this was not used here). The Illustrator Deuteranopia Proof setting worked well in giving an initial overview of how the imagery appears to those with this condition, but did not provide the RGB (red, green, blue) percentages of the simulated colours needed to recreate them.

The Mac OS X utility DigitalColor Meter was used to provide colour readings in RGB percentages for the screen area under the cursor, while designing in Illustrator's Color Blindness Proof setting. This was necessary because the colour information displayed in the Illustrator Color Palette is for the original colour, not the simulated deuteranopic colour. The images created in Illustrator were imported into Adobe Premiere to create the motion.

As existing simulators only work with static images, a prototype desktop implementation of Flatla's CVD simulation software (described in Section 3.2) was used to view a CVD simulation of the motion images. The application rendered visible motion graphics simulated as deuteranopia. Quick key commands allowed easy switching between simulation types.

3.2. CVD Simulation Software

To simulate the appearance of images for people with CVD, CVD simulation software manipulates the spatial representation of colour described above. People with deuteranopia and protanopia (colloquially called red-green colour blindness) have reduced ability to distinguish between greens and reds. The CVD simulation is achieved by shifting the original colour of each pixel along the line parallel to the red-green axis identified above until it meets the plane defined by the blue-yellow and black-white axes. This new colour is then used to replace the original pixel colour to generate the simulated image.

3.3. Recolouring for CVD

Recolouring modifies the contents of an image to improve colour differentiability for people with CVD. This is accomplished by replacing the colours that present difficulties for people with CVD with more differentiable alternatives. For example, suppose an image contains red raspberries against green foliage (a colour combination that will present difficulties for someone with CVD). A recolouring tool maps the colour of the berries to another colour that is more differentiable for someone with CVD (e.g., blue). This introduction of a false colouring scheme restores the perception of colour differences for people with CVD, typically at the expense of preserving the naturalness of the image - blue raspberries are clearly not the norm.

Previous work used dynamic (Jefferson & Harvey 2006) and static (Seewald Solutions 2013) approaches for choosing replacement colours during recolouring. Dynamic recolouring involves analysing the image to identify its main constituent colours, then finding a set of replacement colours that maximally satisfies a set of constraints – typically through constraint optimisation. This approach can help reduce the degree of recolouring that takes place, but is quite computationally demanding. Static approaches rely on a fixed recolouring map, where each individual colour in an input image maps to a pre-determined replacement colour. Static recolouring can tend to result in too much recolouring (e.g., every colour changing), but can be executed very quickly using parallel shaders on the graphics card.

A static recolouring technique was used primarily because of its reduced computational requirement. This allows the recolouring tool to be deployed on a mobile device that allows participants to fully engage with the exhibit.

To construct the static recolouring technique, a mapping of input colours to output colours was developed. To accomplish this, our recolouring tool rotates the spatial colour representation described above by mapping reds to greens, greens to blues, and blues to reds. As discussed above, this results in a large degree of recolouring (see Figure 2), but also allows colours that are not differentiable in any type of CVD to become differentiable. For the purposes of this work the point of the recolouring tool is to allow the colours that are not differentiable for people with CVD to become differentiable so they can appreciate what the participants with typical colour vision perceive. Performing such a severe recolouring guarantees that colour differentiation will be possible for people with CVD.

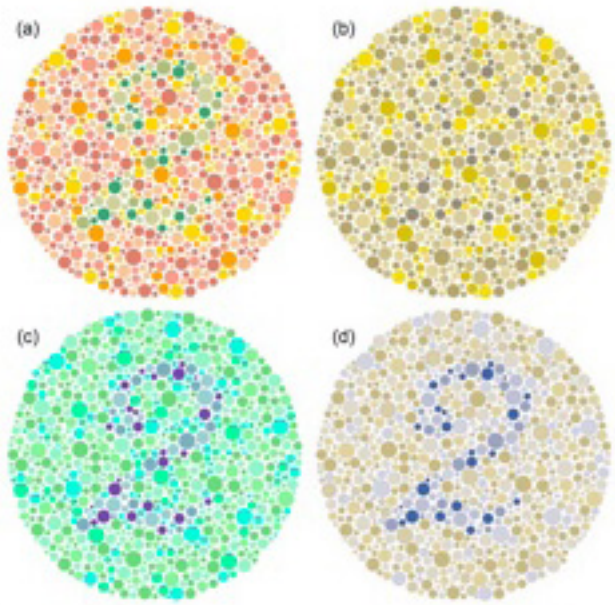


Figure 2: Recolouring demonstration: (a) original Ishihara plate, (b) deuteranopic simulation of the original plate, (c) original plate after recolouring, (d) deuteranopic simulation of recoloured plate.

3.4. Generating Look-Up-Tables for Simulations

Both the simulation and recolouring techniques presented above were described in terms of single images, but to create a mobile application that provides simulated and recoloured views of the world at interactive frame rates, these techniques need to be extended to run in near real time. To do this, the fundamental algorithm used in both simulation and recolouring has been explored to identify where performance can be improved.

At a high level, both simulation and recolouring use almost identical algorithms:

(i) Identify a pixel's RGB colour.

(ii) Manipulate the RGB colour to find its simulated or recoloured version.

(iii) Apply the manipulated RGB colour to the original pixel.

The first and third steps are executed very quickly, so the second step is the bottleneck in the algorithm; both simulation and recolouring involve substantial manipulation of the input RGB colour. These include converting from RGB into other colour spaces that better support the translations performed in simulation and the rotations performed in recolouring, performing the actual colour translations and rotations, and converting the resulting colours back to RGB colour space so they can be applied to the pixel in step three.

To improve the speed of the above algorithm, step two is replaced with a single lookup. CVD simulation and the recolouring technique described above are both deterministic - the same RGB input colour will always result in the same output RGB colour. As the set of RGB colours is fixed (typically with 2^{24} unique RGB colours), then the simulation and recolouring RGB colours for every possible input RGB colour can be computed and stored in a Look-Up-Table (LUT). The input RGB colour is

used as an index into the appropriate LUT (simulation or recolouring), from which the replacement RGB colour is read and forwarded to step three.

To generate the LUTs used for the mobile application used in the exhibit, a single image containing every possible RGB colour was generated, and organised such that a colour's location in the image is dictated by the colour's RGB values. For example, the brightest blue in RGB is represented by 0x0000FF (hex) = 255 (decimal). The location of this blue in the LUT is at index 255. This image was inputted into an implementation of the CVD simulation tools described earlier (Kuhn 2008) to get the CVD simulated view of this image. Once through the simulation, the image colour at a particular RGB input location is no longer the input RGB colour, but the simulation colour. As a result, a single memory lookup can be used to go from input RGB colour to output RGB colour. Three simulation LUTs were generated, one for each type of dichromacy (protanopia, deuteranopia, and tritanopia).

To build the LUT for the recolouring tool, a similar image as the simulations was computationally generated. For each possible RGB colour, the recolouring rotation was performed as described above. The resulting rotated colour was then stored in an output image at original colour's index. In this fashion, a LUT of exactly the same organisation as the simulation LUTs was generated, allowing the mobile implementation to take advantage of these similarities.

3.5. Smart Device Development

To develop the mobile application, the LUTs generated in the previous section were loaded into a folder on the mobile device. We developed an app that looks in this folder when launched and loads all of the LUTs present into memory. On launch, the filename of each LUT is also read, and stored for later use. When the app finishes loading the LUTs, a video feed from the rear-facing camera is started and fed through to the device's screen. The initial screen presents the camera feed without manipulation and a text label indicating no manipulation is being performed (Clear) is displayed in the corner of the screen. To use a simulation or the recolouring, the user swipes their finger across the screen. This switches to the first CVD simulation. At the same time, the text label on the screen is updated to match the filename of the current LUT in use (one of Protanopia, Deuteranopia, Tritanopia, or Recolouring). The LUTs are presented in a circular fashion so if the user swipes past Recolouring, they are presented with the Clear screen again. For the exhibition, this app was implemented using the Android ADK, and deployed on a Google Nexus 7 Tablet.

3.6. Test Panel

Two local subjects viewed images in development, one self identified with red-green CVD and the other typically colour sighted. Once obtaining the desired results from the local subjects, prototypes were emailed to ten additional subjects. They were asked to identify any letters, numbers or patterns seen in the motion graphics. They were then asked to name the colours in the graphic. Responses were collated and adjustments were made in response. Once completed, the process was repeated until appropriate results were achieved. When finished, motion graphics were tested by four subjects, two with CVD and two typically sighted all with positive results. It is hoped that additional responses can be recorded during the public exhibition and viewing with the simulation enabled smart devices.

4. THE ART

4.1. Testing the Colouring Technique

The CVD simulation motion graphic concept was first tested using a page of thirty-three evenly spaced dots of seemingly random colour placement (see Figure 3). To get a variety of hues, Adobe Illustrator web colours were used as well as blue, red, yellow and green selected from them. Magenta and light blue were added to provide variety. The Illustrator proof tool was used to determine what colours the red and green changed to in the deuteranopia mode. A single light-brown hue, between what was represented for the red and green, was selected to replace the red and green dots in the image.

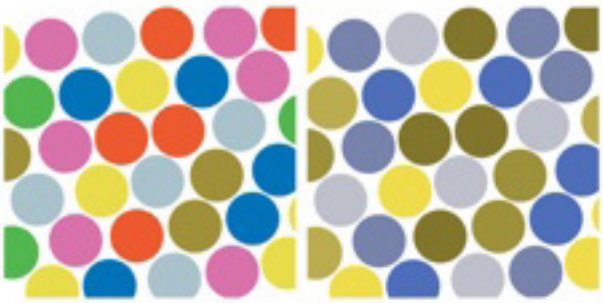


Figure 3: Early attempt at camouflaging visual information. Those with CVD might make out a '6' in yellows and browns. Original colour version on the left. CVD simulation on the right.

In the image, the differently coloured dots were at first arranged randomly. The deuteranopia mode was then turned on and the dots re-arranged such that those which were yellow and light-brown in hue formed the number 6. When the deuteranopia mode was switched back off the dots still looked randomly placed. The local CVD test subject was asked if he could see a number within the dot layout and correctly identified '6'. The local negative control test subject (who does not have colour blindness) was unable to see the 6.

4.2. Testing the Sequencing Technique

The next, more sophisticated test, was inspired by the circles and sequencing lights seen in movie marques and vintage Vegas signage. Simple square grids of up to 100 circles against a black background were created in Illustrator. An on/off sequence of three with the circles radiating out from the centre: off, on, on, off, on, on, etc. was created, with off corresponding to black and on to white. A still of this sequence is shown in Figure 4.

Three image iterations of this were created: (i) with the sequencing starting in the centre, (ii) with it starting one row out from the centre and (iii) with it starting two out from the centre. Between them, these three iterations covered all possible permutations of colour within the off-on-on sequence.

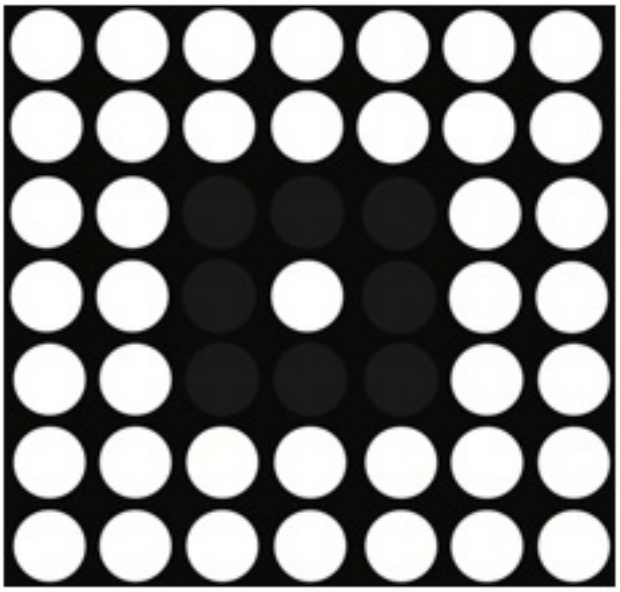


Figure 4: Still of on/off sequence from initial motion graphic tests.

The three iterations were saved and placed in their correct order into Premiere video editing software. Initially each iteration was given six frames. The three images times 6 were then copied and pasted many multiple times into the project window of Premiere. When played, the sequence gave the impression of a square rapidly radiating out from the centre of the image.

4.3. Creating the Art

The third series of tests also used Ishihara imagery as their starting point. Because the circles in the Ishihara imagery vary in size and placement, concentric circles were overlaid on the imagery. If the centre of an Ishihara circle fell within a specified concentric demarcation, then that circle was included within that demarcation. This allowed for less rigid outcomes that better reflected the Ishihara characteristics. Aesthetic expression was more thoroughly explored in this test and required much greater precision in colour selection; which colours the fully-sighted would see and their relationship to the colours they would shift to for those with CVD.

The intent with the initial Ishihara test was to have a green number 27 against a red-orange background and a circular pattern radiating from the image's centre visible to the fully-sighted but only the radiating pattern visible to those with deuteranopia. The colours had to be carefully chosen so that various reds would correspond with various greens exactly, producing the same exact brown when viewed by those with CVD.

In Illustrator, green and red hues of similar saturation and value were selected and used to fill in two circles. Switching to the Color Blind Proof setting in Illustrator rendered the colours in the brown tones of CVD. From these two, the green simulated brown hue was chosen and the DigitalColor Meter was used to determine its RGB percentage reading. A third circle was filled brown using the RGB percentages in the Color Picker. To generate the same brown hue from the red circle, the RGB percentages of the original red hue were manually adjusted until the correct brown hue was visualised through the CVD simulator. This entailed slightly changing one of the RGB percentages, switching to the Color Blind Proof setting and getting a reading in the DigitalColor Meter to see if it adjusted closer or further to the percentages needed for the red hue to match the desired brown hue. This was repeated until the red and brown hues matched (see Figure 5). The entire procedure was used to produce two matching sets of red, green and brown hues. This manual process was streamlined by the production of an RGB percentage table of red and greens that collapsed to the same browns gleaned from the LUTs and used to generate the hues for subsequent pieces of work.

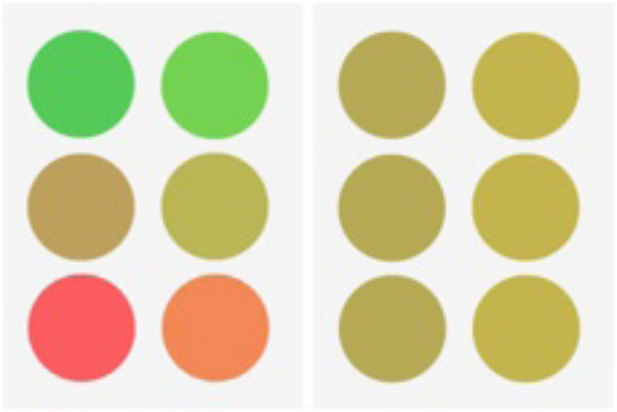


Figure 5: Colour for early Ishihara imagery motion graphic test. Original colours on the left. CVD simulation on the right.

As with the initial test, early versions of the Ishihara imagery were sequenced in steps of three (off, on, on). One of the sets of the colours (red, darker green and darker brown) acts as off in the sequence, the other set (red-orange, lighter brown and lighter green) working as on. As the patterns and effects increased with difficulty, other sequences were developed and tested.

Once a section of the motion graphic was completed, the CVD simulation application was used to get a view of the effect planned for those with CVD (as shown in Figure 6). To be inclusive as possible, the software was adjusted to simulate low to moderate CVD. When the test subjects were able to describe the effects as intended targeted to their visual acuities, the results were considered successful and that section of motion graphic considered complete. For sections where the test subjects did not describe the intended effects, adjustments were made and the process repeated until the desired test subject response was attained. The motion graphics were then viewed using smart devices to ensure correct simulations were displayed. Those with typical colour visions viewed the motion graphics using the CVD simulation software; those with CVD used the recolouring software. The responses were positive for both simulations.

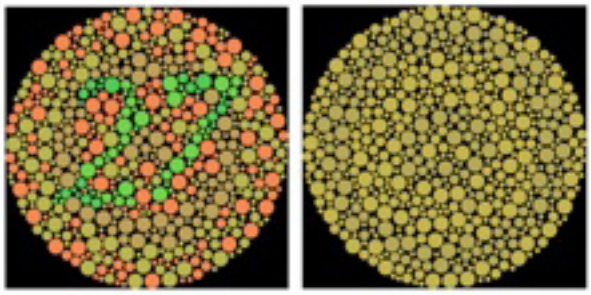


Figure 6: Still from Ishihara imagery motion graphic test. Original colours on the left. CVD simulation on the right.

5. CONCLUSION

Applying an understanding of colour, artistic principles and computer science applications we were able to plan and execute motion graphics that had specific elements apparent only to targeted audiences of specific visual abilities. Using smart devices loaded with our simulation and recolouring applications, we shared those elements with larger audiences. Through these smart devices, those with typical colour vision were able to perceive aspects of the work specifically designed to be visible only to those with CVD. And, using the same smart devices, those with CVD were able to detect aspects of the artwork that would typically be hidden from them.

During this process areas of refinement were identified. Test subjects were used that self identified as colour vision deficient. In the future, those CVD self-identified subjects will be screened to identify the type and severity of CVD to help ensure proper interpretation of responses.

Prototype art targeted those with full colour vision and those with deuteranopia, the most common form of CVD. Through further development we believe that artwork can be designed that engages deuteranopia and protanopia simultaneously, with the expectation of creating mechanisms to include tritanopia (colloquially blue-yellow colour blindness).

It is our hope that through broad exhibition of the work, germane feedback can be amassed and the work thoughtfully progressed.

6. REFERENCES

Asada, K. (2011) The Day I Saw Van Gogh's Genius in a New Light. http://asada0.tumblr.com/ post/11517603099/the-day-i-saw-van-goghs-genius-in-a-new-light (17, March, 2014).

Australian Government. (2014) It's an Honour. http://www.itsanhonour.gov.au/honours/honour_roll/search.cfm?aus_award_id=870096&search_type=quick&showInd=true (17 March, 2014).

Brettel, H., Viénot, F. and Mollon, J.D. (1997) Computerized Simulation of Color Appearance for Dichromats. *Journal of the Optical Society of America A*, 14(10), 2647–2655.

Cole, B. and Harris, R. (2009) Colour Blindness Does Not Preclude Fame as an Artist: Celebrated Australian Artist Clifton Pugh was a Protanope. *Clinical & Experimental Optometry*, 92, 421–428.

Flatla, D.R. and Gutwin, C. (2012) "So That's What You See!" Building Understanding With Personalized Simulations of Colour Vision Deficiency. In *Proc. ASSETS '12*, 167–174. ACM, New York, NY, USA.

Jefferson, L. and Harvey, R. (2006) Accommodating Color Blind Computer Users. In *Proc. ASSETS '06*, 40–47. ACM, New York, NY, USA.

Lyons, D. (2013) Testing Times. *Printmaking Today*, 22(4), 24–25.

Meyer, G.W. and Greenberg, D.P. (1988) Color-Defective Vision and Computer Graphics Displays. *IEEE Computer Graphics & Applications*, 8, 28–40.

Sacks, O. (1995) *An Anthropologist on Mars: Seven Paradoxical Tales*. Alfred A. Knopf, USA.

Seewald Solutions. (2013) ColorBlindness SimulateCorrect. https://play.google.com/store/apps/details?id=com.SeewaldSolutions.ColorBlindnessSimulator (21 March, 2014).

The Bullwinkle Show. (2011) Bullwinkle Show Intro. https://www.youtube.com/watch?v=ejgfnRvAOno (17, March, 2014).

The Gong Show. (2006) Oingo Boingo on the Gong Show.https://www.youtube.com/watch?v=vTRd1a5MVMw (17, March, 2014).

DOUBLE VISION
Impact 9, 2015 Proceedings, Hangzhou China
David Lyons, Raz Ullah, David Flatla
Double Vision: The integration of Printmaking and Motion Graphics through Video Mapping

Double Vision is a proof of concept collaboration between artists David Lyons and Raz Ullah, produced with the aid of software developed by computer scientist David Flatla. The aim of the artistic experimental pieces that comprise Double Vision is to further explore the idea that artwork can be intentionally created to be experienced differently depending on one's visual abilities. Our approach was to enhance the medium of printmaking through contemporary techniques and new, inclusive technologies that appeal to audiences of varied visual acuities. This paper is an overview of the concepts, processes and practices that drove this project while giving context of how this project fits into and furthers this ongoing line of research.

Double Vision consists of a set of three black and white prints that, when combined with motion graphics spatially mapped onto their surfaces, create potent visual experiences for both colour blind and typically sighted audiences. A audio soundscape accompanies the prints. Companion smart devices programmed with specially designed augmented reality software are provided to visually translate the experiences for these two audiences, thereby adding further levels of interaction.

CONTEXT
Double Vision progresses ideas from three previous works: The Double Blind Test Series of prints (Lyons 2013); The Colour Blind Test Series of prints; and the motion graphics of Eye for an Eye (Lyons and Flatla, 2014).

Each of these works relied in part on imagery influenced by the Ishihara Colour Blind Test plates which are used to test for the red-green colour vision deficiency (CVD) commonly known as ‘colour blindness’. The Ishihara test plates can distinguish between the two types, protan and deuteran, and determine the severity of each. The circular images on the Ishihara plates are comprised of smaller circles of various sizes with patterns and numbers camouflaged within them. They are familiar to many, having been in regular use to diagnose colour blindness for just short of a century.

The Double Blind Test Series
In this work Lyons’ used Ishihara imagery as a starting point for pieces with differential appeal to fully sighted and colour blind audiences. The print Anonymous Play, for example, strove to make the number six visible only to those with red-green CVD. The Double Blind Test Series was positively received and drew those with CVD, including

computer scientist David Flatla, to the exhibition (Figure 2). Flatla's own research aims to help people with impaired colour vision by modelling colour vision, adapting digital content to make it more accessible, and providing tools to enhance colour identification. A shared desire to refine techniques for creating differentially viewable artwork and to develop a body of art that engages multiple audiences simultaneously led to the Lyons and Flatla collaborating in subsequent works.

The Colour Blind Test Series

The four prints of the Colour Blind Test refined previous approaches to make specific imagery visible to those with CVD and other imagery visible to those with typical colour vision in the same pieces. In the Sheep and Goat prints, colour was used to suggest a bull's eye target for those with typical colour sight, but a series of chevrons for those with CVD (see figure). In Heaven and Hell, viewers with typical and CVD vision saw different patterns of vertical and horizontal coloured bands. Augmented reality software was developed with David Flatla to allow those with CVD to visually experience what they typically colour sighted saw, and vice versa.

Eye for an Eye Motion Graphics

In Eye for an Eye motion graphics that contained visual messages targeted to differing visual abilities were created (Lyons, Flatla, 2014), based on two principles extrapolated from Lyons' previous work.

People with red/green CVD perceive reds and greens as a range of muddy yellows, and certain pairs of red and green are perceived as the same muddy yellow. These pairs of colours are referred to as 'confusion colours' to those with CVD. The confusion of reds and greens arises from a reduction in functionality in one of the three types of light receptors called cones, on the retina. Each type of cone detects a different range of light wavelength. Protan and deuteran Red/Green CVDs are caused by reduced function in the cones that detect long or medium wavelength light, respectively; the range of visible colours, collapses along the yellow/blue axis of vision such that most reds and greens look like muddy yellows.

People with CVD and the typically colour sighted visually group colours differently. The typically sighted tend to visually group warm colours (reds and magentas) and cool colours (blues and greens) separately. Those with red/green CVD group colours differently, into muddy yellows (reds and greens to the typically sighted), and blues (comprising the blues and magentas seen by the typically sighted). Thus, contrast for the typically sighted can be created using cool colours and warm colours, whereas for those with CVD, contrast comes from using muddy yellows and blues.

These colour perception variations were used to generate different visual experienc-

es, and messages to one audience that were camouflaged to the other. The effect of motion was created in much the same way that the light bulbs in a movie theater marquee create the illusion of 'chasing' by being turned on and off in a pre-programed sequence. In the motion graphics, the circles were not 'turned on and off' as the lights are in the marquee, rather the colour in each of circles changed in a pre-ordered sequence.

INSPIRATION

During preparation for the exhibit of the Double Blind Test Series and Eye for an Eye in July 2014 at the Hannah Maclure Centre Gallery in Dundee, Scotland, gallery director Clare Brennan suggested that the motion graphics of Eye for an Eye might be more effective as projections rather than presented on a monitor. The exploration of printmaking as a discipline effective for communicating to audiences of varied visual abilities lead to the development of the motion graphics being projected onto black and white prints that mirrored the motion graphics. Raz Ullah was recruited for his technical expertise, which was further exploited with the addition of the accompanying soundscape.

THE DOUBLE VISION PRINTS

The three prints of Double Vision are 86 x 86 cm black and white inkjets printed onto Somerset Enhanced Velvet 330gm paper. Influenced by the Ishihara Colour Blind Test, the prints in Double Vision are void of colour and use black instead of white for the background/negative space. No colour beyond the white of the paper and the black of the inks are used on the prints, allowing each of the white spaces to act as reflective screens for projected circles of changing colour. Projecting only black onto the black areas of the prints achieved a very high contrast between the brightly coloured areas and the saturated black areas of the projections on the prints.

THE DOUBLE VISION MOTION GRAPHICS AND PROJECTIONS

Double Vision uses motion graphics developed from Eye for an Eye, in combination with Projection Mapping. This video projection technology allows the user to position, scale and distort video content via a software interface so that it can be displayed on 3D objects. It can add extra dimension, optical illusions and impressions of movement to static surfaces, and is widely used in performance, installations and advertising.
For the purposes of this installation VPT6 was used – a free, open source projection mapping software system developed by Norwegian video artist HC Gilje [1]. VPT6 can display eight different video streams, each of which can then be positioned and scaled to accurately fit the surface onto which they will be projected.

The first stage of the process involved positioning the projector so that it covered the entire area where the prints were displayed – a distance of six metres from the easels

holding the prints was sufficient. The three motion graphic videos were then loaded into the software interface, assigned to three different output layers and set to loop indefinitely. Each graphic was then positioned roughly over each print, ready to be precisely mapped onto the corresponding white dots. This final stage of the process required two people – one to operate the software and the other to stand close to the prints and give feedback as to how many increments the graphics had to be re-sized to fit.

Once each graphic had been positioned correctly, the effect was very dramatic with each print seemingly becoming more ‘active’ and more reminiscent of a lighting display rather than a static print. The deep black around the white dots was highly effective in absorbing much of the light from the projector, with the result that the main body of the print became very bright. This, coupled with the fact that the installation was set up in a completely dark space, created a highly engaging visual environment that visitors were keen to spend time exploring.

SOUNDSCAPE

The sound piece that accompanied the projection-mapped prints was developed to create a completely immersive environment that would draw visitors into the space and heighten their senses while interacting with the prints.

The soundscape consisted of several layers of white noise, drones generated by an analogue synthesizer and induction-coil microphone recordings of computer monitors, television screens and electronic signs that generate a minute amount of static electricity. The overall effect was one of being immersed in an electrically-charged environment – a design choice influenced by Lyons’ interest in movie marques.

Two large speakers were set up at the rear of the room to project the sound directly into the space and several different volume levels were tested before deciding on an appropriate level that would create the desired ambience and not overwhelm visitors or direct attention away from the prints.

COLOUR TABLES

To choose the confusion colours used in the motion graphics, tables of RGB numbers corresponding to red, greens and muddy yellows were created. To create the sets of confusion colours used in the tables, we first generated sets of colours with similar relative perceived luminance (brightness) at five different brightness levels (40%, 45%, 50%, 55%, 60% the brightness of pure white) within the CIE L*u*v* colour space, a commonly used computer graphics colour model. Within colours of similar relative perceived luminance in this colour space, sets of indistinguishable colours for people with CVD lie along straight lines - leading to the term 'confusion lines'. The confusion lines

for protan and deutan CVD are closely aligned, but not exactly parallel with each other. As such, we chose lines of colours that were sufficiently parallel to confusion lines for both protan and deutan CVD to contain colours that are confusing for both types of CVD, but are distinguishable for people with typical colour vision (see figure).

To select colours for the exhibit, colours along the lines described above were chosen such that they were clearly distinct for people with typical colour vision (e.g., orange and green). Due to these colours falling on lines that are roughly parallel to the confusion lines for protan and deutan CVD, our colour choices are not differentiable for people with CVD. The table provided RGB numbers for the 'confused' red, greens and muddy yellows that could be used to identify colours in the design software used to construct the motion graphic.

AUGMENTED REALITY SOFTWARE

During the showing of Double Vision, tablets with specially designed software were available that allowed those with typical colour sight to view what those with CVD were seeing, and those with CVD to view what those with typical sight were seeing.

The CVD simulation software emulates the collapsing of the visual colour spectrum experienced by those with CVD. A digital image of the artwork is captured by a video camera connected to a computer and viewed in real time. The software identifies colours in the digital image, pixel by pixel, and substitutes those colours for the ones they collapse to on the blue/yellow axis.

The recolouring for CVD software also acts on images captured by a video camera connected to a computer, The recolouring tool rotates the RGB colour representation used by the computer to GBR. Consequently, red becomes green, green becomes blue and blue becomes red. For example, suppose an image contains red strawberries against green foliage (a colour combination that will present difficulties for someone with CVD). The recolouring tool maps the colour of the leaves and berries to another colour combination that is more differentiable for someone with CVD (e.g., blue leaves and green berries). This introduction of a false colouring scheme helps restores the perception of colour differences for people with CVD.

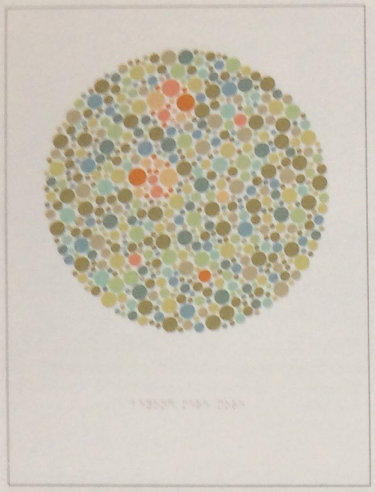
CONCLUSION

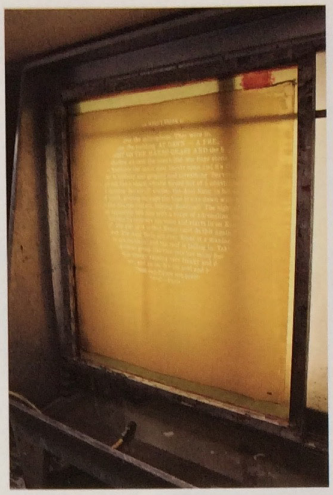
In Double Vision we were able to take the successes in engaging audiences of varying colour vision abilities and create a new platform of expression, the projection mapped motion graphic print. Over 300 people attended the initial showing with invigilators receiving overwhelming positive remarks, and the enthusiasm translating into new and additional collaborations.

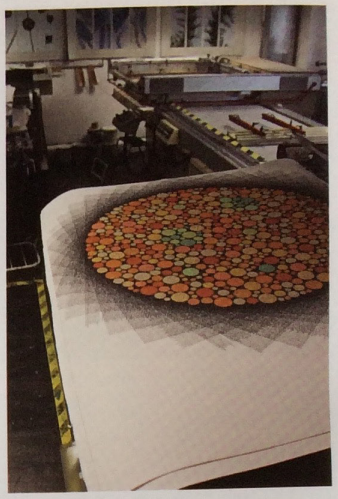
The unexpected result of the work was its visual impact. The intensity of the colour contrasted against the black transformed both the prints and the projections into an experience that was more than the sum of the two parts. The colours appeared to be radiating from an internal source while the black became a void rather than a surface.

Further exploration of the concepts and techniques behind Double Vision are underway, including increasing the scale of the prints, the use of multiple projections onto a print and further integration of sound and motion.

TECHNICAL







Testing Times

TECHNICAL David Lyons describes the experimental genesis of a series of prints that examines how sight influences perception, designed to engage an audience of varying visual abilities

The Double Blind Test Series comprises twelve visually and tactilely expressive prints that evolved from my interest in typographical approaches to Braille. I wanted to create a system for Braille that paralleled contemporary typography. My inspiration for exploring a texturally expressive Braille came from my own experiences moving from classroom teaching to an online environment, where I found it difficult to effectively communicate with my students. My online type-written comments did not convey important information contained in my intonations, my facial expression or my body language. In doing research for a typography lecture, I came across a reference to Braille. I was struck by the idea that Braille serves only to communicate hard information, much like my typed words, whereas typography allows printed text to additionally convey context and nuance.

At the Dundee Blind and Partially Sighted Society I approached blind and partially sighted people with my ideas of an enhanced Braille. Their response was negative. Form follows function. It does what it needs to do. No improvement is needed. This was a revelation: I had proposed to them a solution for a problem that did not exist. But it did not deter me from forging ahead.

I worked with The Arts and Crafts Group within the Dundee Blind and Partially Sighted Society to redevelop my ideas. The group members' disabilities vary from complete blindness to mid-stage macular degeneration. Although their sight is impaired, visual creativity, including mark making and recognizable imagery, continues to be important. Black and white images were coloured in and collages were created.

Shortly thereafter, I had the good fortune of having Graham Pullin, from Duncan of Jordanstone College of Art and Design, view an early presentation on my experiences with the Blind Craft Group. He forwarded me a chapter of his book Design Meets Disability, in which he observes: 'Braille is interesting and beautiful, as abstract visual and tactile decoration, intriguing and indecipherable to the non-reader'. He continues: 'Braille could be decorative for sighted people.' I found this idea intriguing.

My experiences with the Arts and Crafts Group and the idea of Braille as a decorative element brought to mind other images that play with sight and perception: the black and green American flag after-image, the Op Art of Vasarely and, most importantly, the Ishihara Colour Blind Test that I took at school with its strangely compelling painterly design. My interest in perception and hidden meanings was rekindled. As Braille's messages are hidden from the sighted, so the numbers and patterns of the Ishihara Test are hidden from the colour blind. Interestingly, some numbers are also obscured for the fully sighted, with the colour blind seeing different numbers in some of the plates.

Hidden meaning

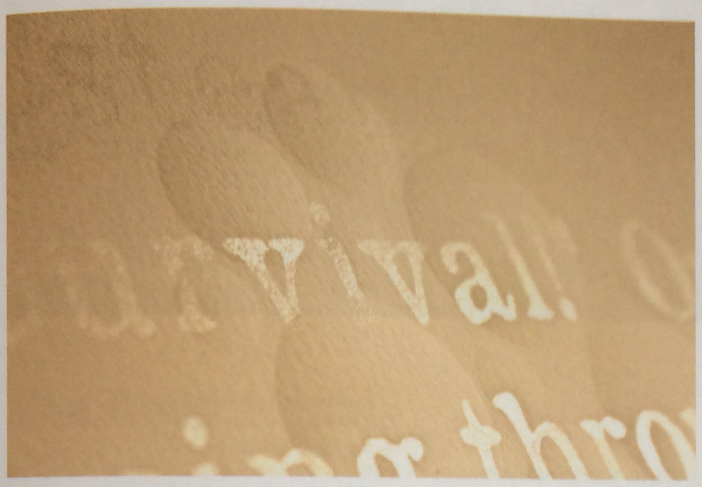
Perception became the new driving force behind the imagery I was developing. I liked the idea of consciously creating something that could be experienced differently dependent on one's visual abilities and sensibilities, where some of the messages of the work would be perceived only by certain audiences and those with different abilities would experience the work not only differently but in ways that had hidden meanings and messages. The challenge could be to engage those abilities and perceptiveness in the same piece.

While I did not want to just mimic the Ishihara Test, I did want to keep many aspects of it and referenced them throughout the development of the imagery. The Ishihara plates segment viewers into various populations based on their visual abilities. I hoped my interpretations would alternatively be inclusive. I wanted the Ishihara Test reference to be immediately obvious and retained many aspects of the layouts, motifs and colours. As I started to layout the work, one of the first considerations was how to get colourful prints that reflected the Ishihara plates while allowing for a textured surface for the Braille-influenced elements. Braille was incorporated by replacing the camouflaged Arabic numbers found in the Ishihara plates with raised and visually identifiable Braille numbers. Also, each print has a selection of text set in raised Braille in the lower third of the print. To create additional visual interest, I varied the chroma of the hues and the values of the grays sampled from the original Ishihara plates. The Ishihara plates do not test for the rare blue-yellow colour blindness so I created my own, based on colour spectrum illustrations for blue-yellow colour blindness. This functioned both to include another partially sighted group and increase the colour variations between prints.

Working spontaneously

I have always liked the tactile elements and techniques of printmaking and I realized I could exploit the tactile nature of Braille through those techniques. I experimented with screenprinting and flocking, trying out various adhesives including clear bases and PVA glue. I applied flocks in different ways: floating it on, blowing it on and building a box to shake it on, all to varying degrees of success. I experimented with screen meshes from 43T to 140T.

I tried different puff inks, settling on Permest Puff Paste. The first experiments consisted of finding the right amount of puff base to add to the ink base. Some of the experiments failed because of the added variable of drying temperatures. In



experiments with drying temperatures I got encouraging results with a heat gun over small areas. But when tried over larger areas, the inks would begin to set before I could heat them to an adequate temperature with the gun. Tests with large prints and high heat in a print dryer resulted in puffy inks – but triggered fire alarms.

After I had created the imagery for the first print and settled on the tactile approaches, I inkjet printed a large proof. As I looked at it, I realized that I had made a practical mistake. If some of the elements of the print were to be flocked or use puff ink and others embossed, each would flatten the others out in successive runs. I could not run a print with puff ink on it through a press to emboss other elements and expect the puff ink to remain puffy. This realization lead to my final approach of inkjet printed colours, screenprinted varnishes and embossed textures.

Next I considered print size. Initially, I leaned towards a manageable size for the multi-step process that would be involved, but I also wanted to vastly increase the originals' A5-sized visual impact. Visual impact won out. As a result each print is 840 x 1120 mm with a 660 mm or bigger circular image centred in its upper two-thirds. This large circle comprises smaller circles of various size and hue. Many of the circles are overlaid by texts from William Blake, Aldous Huxley and Tom Wolfe to provide additional visual texture. The source texts offer both explicit and implicit commentaries on vision and visions. For use in the prints, I stripped the texts of their formatting, and reset them in the Old Newspaper typeface to emulate the look of mid-20th-century publishing. I laid them out in large blocks, then masked them using the circles of the Ishihara-inspired layouts, resulting in overlays of words that were randomly sampled from the texts by their interaction with the imagery. I chose this random approach to text as an homage both to the random text poems of Allen Ginsberg (who features in Wolfe's *The Electric Kool-Aid Acid Test*) and the double-blind, randomized test protocols alluded to in the series title. In the lower third of each print there is a line of embossed Braille text: an enigmatic excerpt from the accompanying image.

Enlarged and abstracted Braille numerals are visually and tactilely embedded in the circular images of some of the prints. In others, only tactile Braille numerals are embedded, and one print contains an Arabic numeral visible only to the colour-blind. To continue the emphasis on visual and tactile texture, multiple printing techniques were used, including inkjet printing, screenprint and embossing. These devices and variations intend to subvert the original meaning of the colour-blind test, and communicate different modes of perception.

Final touches

A 6mm hardboard was used as plates for embossing. The positive embossed circles on the print were created from negative areas on the plate. The plates were laser-cut at the Dundee Contemporary Arts Print Studio, where printmaker Scott Hudson advised me on settings to achieve the various depths of cuts required. The negative areas were taken from the original Illustrator files and imported into the laser cutter interface and then the circles were cut from the hardboard. The settings worked so well on the first plate that they were used again for the remaining 11 plates.

The colour for the series was printed on an EPSON Stylus Pro 9800 using Ultra Chrome K3 inks onto Somerset enhanced velvet 100% cotton paper. The paper was chosen because its tooth and weight worked well in initial embossing tests. The inks were used because of their dense pigments and 100+ year lightfast ratings.

With the assistance of artist and researcher Paul L. Harrison, the screenprinting of the varnishes was done in the Publishing Press Room of the Visual Research Centre in Dundee. Slightly tinted TW Graphics water-based gloss was pushed through a 120T screen. After viewing the first proofs, the varnish was double printed to increase its density.

Embossing was done on The Clydesdale Press at Duncan of Jordanstone College of Art and Design. Printmaking technician Mark Hunter helped me achieve sharp, deep embossments. Initial proofs revealed multiple problems. During soaking and printing the inkjet inks ran, the paper stretched considerably, throwing off registrations, and the paper tore in the larger embossed areas. Lightly misting the back of the paper with water rather than soaking and adjusting the print pressure to allow the addition of large foam rubber sheets between the paper and the blankets solved these issues. The inks did not run, the embossings did not tear and the paper stretched less. Additionally, the prints did not buckle nor did they require drying.

The layering of Braille elements, literary texts and the Ishihara Colour Blind Test into the imagery and texture of the prints are the results of the experiments, insights and realities of practice. The prints reflect my original misguided desires, personal interests and production practicalities resulting in work that by design is inclusive.

Contact
www.mrdavidlyons.tumblr.com

Images, left to right
Working Spontaneously Would Be Rash 2013 Embossed inkjet and screenprint, 840 x 1120 mm
Screen for *Cannot Fatten Words*
Publishing Press Room of the Visual Research Centre in Dundee
Cannot Fatten Words (detail) 2013 Embossed inkjet and screenprint, 840 x 1120 mm
Buddha Accordion (detail) 2013 Embossed inkjet and screenprint, 840 x 1120 mm

ESSAY

FEWER LOOKS OR ALIEN LOOKS?

Dr Martin Lipman. 09 07 2015

Written in response to the Eye for an Eye and Double Vision exhibits.

Fewer looks or alien looks?[1]

I'm colour blind, a so-called red-green dichromat. I'm unable to distinguish pairs of visual stimuli that respectively appear red and green to those with normal colour vision. My partner isn't colour blind. We look at the Heaven and Hell diptych and see different things displayed on the wall in front of us. Some of the dots look the same to me whilst looking different to my partner. She wonders how things appear to me. I wonder how things appear to her.

The question is much broader than this. Although there are typically three types of cones in human retinas, there are four types of cones in goldfish. They have tetrachromatic colour vision. Their cones are sensitive to the near ultraviolet and discriminate between wavelengths that we do not discriminate between (Byrne and Hilbert 2007: 94). How on earth does the world appear to my goldfish? I'm to my partner what my partner is to my goldfish. And this is just the tip of the iceberg.

There are two philosophical views on this question, the so-called Reduction View and Alien View (Byrne and D. R. Hilbert 2010). According to the Reduction View, a red-green dichromat like myself suffers from a reduced range of colour appearances: things do not truly look red or green to me. Things simply lack these looks in my experience. According to the Alien View, a red-green dichromat like myself does not enjoy a reduced range of colour appearances: although things do not look red or green to me, they instead look some other colour entirely. On the Reduction View, things look to the goldfish the way they do to us whilst looking some more ways besides these, on the Alien View the difference in hue sensitivity infuses all the coloured looks. Things look alien ways to the goldfish (cf. Hardin 1993: 146).

Aren't these sorts of things settled by science? Indeed, isn't the issue settled by the transformation apps used in the exhibitions of Lyons? I look at the iPad and learn how things appear to my partner. She looks at the iPad and learns how things appear to me. Done. That is how things appear to us. The Alien View stands refuted.

But things are less easily settled than one might think. It is one thing to test for discrimination via appearances, and to simulate discriminations where one cannot ordinarily discriminate; it is quite another thing to figure out what sort of appearances underwrite the relevant discriminations. My partner might discriminate between two dots because the one looks red and the other looks green, whereas I do not normally discriminate between them. But I can discriminate between blue and yellow, so just make one dot appear some shade of yellowish and the other some shade of blueish to me and I will now be able to see a contrast in hue between the dots, changing the patterns I see. All fine and well. But I do not thereby learn what it is

for things to look red if I cannot see red – one might think. Similarly my partner does not truly learn what it is like to be colour-blind. As the scientist Boynton realized: 'the issue of what dichromats "really" see probably can never be fully resolved' (1979: 382; quoted in Broackes 2010).

To illustrate this further, consider a thought experiment (due to Shoemaker 1982). The thought experiment involves someone, call him Nonvert, who experiences red things exactly the way normally sighted people experience red things and someone else, Invert, who experiences red things exactly the way normally sighted people experience green things. The colour appearances that things have are inverted on the colour spectrum to Nonvert and Invert. Both have been like this since birth. Both discriminate between the same things under the same conditions. Both are part of the same linguistic community, describing the same things as red, green, etc. So both Nonvert and Invert call a tomato red, grass green, and so on. How could Nonvert find out how the world appears to Invert? She cannot ask Invert (who will report seeing red when looking at a tomato), she cannot observe any difference in behaviour (as Invert makes the same discriminations as everyone one), she cannot simply check Invert's brain, as looking at the grey mass in a skull doesn't tell how things appear. The thought experiment illustrates how little access we have to the way the world appears to others.

Back to the exhibition, the Heaven and Hell diptych in front of us. Where she sees horizontal patterns, I see vertical ones. The iPad – we are told – shows us the prints as they look to the other.

First a sense of isolation. How different the world looks to us. It is not just colours. As the prints remind us: seeing different colours can sometimes mean seeing different patterns, different shapes, different messages. We live our lives on the assumption of inhabiting a shared world. But in the company of these prints, this assumption of a fully public, transparent world seems a comfortable illusion, naïve. The colours things appear to have around us directly influences the way we feel and respond, and things appear to have radically different colours to different people.

Then an unexpected sense of familiarity. After all, I can make perfect sense of what is on the iPad. The use of the technology is suggestive of the hope that technology may allow us to bridge seemingly incommensurable gulfs in our perspectives on the world. What does the world look like to my goldfish, with her four types of cones? I thought I could not even begin to imagine what things look like to her; I thought I could never imagine the world looking in ways that I'm entirely unacquainted with (cf. Nagel 1979). But one might say the exact same about my capacity to imagine what the world looks like to my partner if I simply do not know what it is like for things to look red. And yet here I am, seeing the patterns she sees, the messages she picks up from the work. Perhaps the experienced world of other creatures, including fellow human beings, is not as inaccessible as we thought. The message is ultimately a comforting one: perhaps we can access each other's worlds.

But then a sense of philosophical vertigo. Yes there is a label telling me that I see the prints as colour-sighted people see the print – but is that right? How could we even know this? It is a perfectly coherent hypothesis that both the prints and the iPad appear in certain ways to my partner, whereas both the prints and the iPad appear in altogether alien ways to me. In the context of the Alien View, the significance of the work becomes more sinister. The hidden messages now remind us of just how much can be in appearances lying beyond our reach. The differences in the way things look on the prints and the iPad now remind us of the true and deeper alienation arising through our potentially incommensurable perspectives on the world.

Notes

[1] The work of David Lyons takes on different flavours in the context of different views in the philosophy of colour. Here I want to draw out how this is so. I'm basing the discussion on work displayed at the Eye for an Eye launch event at the Hannah Maclure Center, on the 28th of June 2014 in Dundee, Scotland; and on work displayed at the Double Vision event at the Visual Research Centre of Dundee Contemporary Arts, on Wed 1st of July in Dundee, Scotland.

References

Byrne, Alex and D. R. Hilbert (2010). 'How do Things Look to the Color-blind?' In Jonathan Cohen & Mohan Matthen (eds.), Color Ontology and Color Science. Mit Press: 259-291.

Byrne, A. and D. R. Hilbert (2007). Color Primitivism. Erkenntnis 66.1, 73-105.

Boynton, R. M. 1979. Human Color Vision. New York: Holt, Rinehart and Winston.

Broackes, Justin (2010). 'What do the colour-blind see?' In Jonathan D. Cohen & Mohan Matthen (eds.), Color Ontology and Color Science. Mit Press. 291-405.

Hardin, C. L. 1993. Color for Philosophers: Unweaving the Rainbow (expanded edition). Indianapolis: Hackett

Nagel, T. (1979). 'What is it Like to be a Bat?' in Mortal Questions. T Nagel (Ed.). Cambridge: Cambridge University Press.

Shoemaker, S. (1982). The Inverted Spectrum. Journal of Philosophy 79.7, 357{381}.

Double Vision Survey

During the opening of Double Vision at the Visual Research Centre of Duncan of Jordanstone College of Art and Design, a survey was made available. The following is the accumulated data of the 14 completed surveys.

Question Response:	Yes	Maybe	No
1. Is the colour blind test imagery familiar?	92% (13)	0	8% (1)

Comments:
Remember it from school.

2. Did being familiar with the colour blind test give your insight into what messages, ideas or themes these prints might be communicating?	64% (9)	28% (4)	14% (2)

Comments:
I could assume that variations in colour would create different experiences for different people.

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?	85% (12)	14% (2)	0

Comments:
Scale of detail changing – focus on overall or minute cell like elements.

4. Did you interact with the computers and software?	86% (12)	N/A	14% (2)

Comments:
The colour changes were fantastic.

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?	86% (12)	7% (1)	7% (1)

Comments:
The screen quality could be improved to compliment the artwork more effectively.
I didn't fully understand the significance of the changes in colour – but enjoyed seeing how the different patterns change.

6. Did you interact with the projected piece?	86% (12)	N/A	14% (2)

Comments:
Blood FAB!
Moving within the space, getting close to the screen.

7. Did you interact with the soundscape?	57% (8)	N/A	14% (2)

Comments:
Didn't know you could.
The soundscape is intriguing but how does it relate 'conceptually'.

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently? 44% (6) 28% (4) 28% (4)
Comments:
After this question I started to think about this.
I found the soundscape most effective when interacting at close range of the projectors.
It was hard to tell if it changes in sound initially as the soundscape changes anyway.

9. Were there any themes in the art that you felt were well expressed?
Comments:
It was all great. Gives a very good idea how others see things.
Lovely stuff, Dave!
Altered visual perception.
Colourful shadows were great!
I really liked the layers of 'ways of seeing '
The text in the framed prints invited inspection and were beautiful to experience
Really liked the theme of perception being down to the individual
Perception
Different (visual) perspectives
Interactive piece particularly expressive
I think it possibly needs a little bit extra information on each element of the exhibition – especially if experiencing on your own.
It was interesting to see the different layering of information that were involved within the image and the idea of different people being able to experience it differently from myself is intriguing.
The feeling, emotion that are absorbed out of the viewer.
Great interaction!

10. Any other thoughts that you have on the exhibit will be helpful:
Comments:
Really enjoyed the exhibit.
Felt dizzy and that was without a beer after the soundscape/projected piece
Touching the artworks
I really enjoyed it – the calibre of the art was very high, Great Artist!
Excellent work – hope to see more of it!
"With your thoughts you make the world'
Nice work man.
For a research exhibit it might be helpful to have a little more explanation as to the intention in each piece – even if this is offered in a separate booklet.
Colours, expression, atmosphere, detail all worked perfectly together
Brilliant show!

[Percentages are rounded to equal 100%. (#) = Number of responses]

Double Vision (Ball of Confusion) Questionaire

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes (Maybe) No N/A
   b. Comments:
      first ideas, but not the whole concept

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes (Maybe) No
   b. Comments:
      After this question I started to think about this

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:
      different (visual) perspectives

10. Any other thoughts that you have on the exhibit will be helpful:
    touching the artworks...

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes Maybe (No) N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:
   Scale + detail changing → focus on overall or minute cell like elements

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:
   Interactive piece particularly expressive

10. Any other thoughts that you have on the exhibit will be helpful:

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments: remember it from school.

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes Maybe (No) N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments: the colour changes were fantastic

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments: Good FAB!

7. Did you interact with its soundscape?
   a. Yes (No)
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments: It was all Great
   gives a very good idea how others can see things.

10. Any other thoughts that you have on the exhibit will be helpful:

really enjoyed the exhibit.

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. Yes Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. Yes Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. Yes No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. Yes No
   b. Comments:

7. Did you interact with its soundscape?
   a. Yes No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:

10. Any other thoughts that you have on the exhibit will be helpful:

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. (Yes) Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:

7. Did you interact with its soundscape?
   a. Yes (No)
   b. Comments:
      DIONT KNOW YOU COULD

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:

10. Any other thoughts that you have on the exhibit will be helpful:
    FELT DIZZY AND THAT WAS WITHOUT A BEER
    AFTER THE SOUNDSCAPE/PROJECTED PIECE

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. (Yes) Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments: – The soundscape is intriguing but how does it relate "conceptually"

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes (Maybe) No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:
   Lovely stuff, Dave!

10. Any other thoughts that you have on the exhibit will be helpful:

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. (Yes) Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:
   Moving within the space, getting close to the screen.

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe (No)
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:
   Altered visual perception

10. Any other thoughts that you have on the exhibit will be helpful:

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. Yes Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. Yes Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. Yes No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. Yes No
   b. Comments:

7. Did you interact with its soundscape?
   a. Yes No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments: colourful shadows were great!

10. Any other thoughts that you have on the exhibit will be helpful:

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. (Yes) Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes (Maybe) No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:
   I really liked the layering of 'ways of seeing/speaking'

10. Any other thoughts that you have on the exhibit will be helpful:
    I really enjoyed it - the calibre of the art was very high, Great Artist!

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. Yes Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. Yes Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. Yes No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:
   The screen quality could be improved to complement the artwork more effectively

6. Did you interact with the projected piece?
   a. Yes No
   b. Comments:

7. Did you interact with its soundscape?
   a. Yes No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:
   The use of text in the framed prints invited interaction and were beneficial to experience

10. Any other thoughts that you have on the exhibit will be helpful:
    Excellent work – hope to see more of it!

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. Yes Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes Maybe No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. Yes Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. Yes No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. Yes No
   b. Comments:

7. Did you interact with its soundscape?
   a. Yes No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments:

Really liked the theme of perceptions being down to the individual — "with your thoughts you make the world"

10. Any other thoughts that you have on the exhibit will be helpful:

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. (Yes) Maybe No N/A
   b. Comments: .

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. Yes (No)
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments:

6. Did you interact with the projected piece?
   a. Yes (No)
   b. Comments:

7. Did you interact with its soundscape?
   a. Yes No
   b. Comments: How?

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes Maybe (No)
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments: Perception

10. Any other thoughts that you have on the exhibit will be helpful:

Not sure about the wording of this question.

Nice work man :)

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. (Yes) Maybe No
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes (Maybe) No N/A
   b. Comments: I could almost that variation in colour would create different experiences for different people

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. Yes (Maybe) No
   b. Comments: It was hard to gauge what kind of level of information was exactly being communicated

4. Did you interact with the computers and software?
   a. (Yes) No
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world, differently?
   a. (Yes) Maybe No
   b. Comments: I didn't fully understand the significance of the changes in colour - but enjoyed seeing how different filters change it visually

6. Did you interact with the projected piece?
   a. (Yes) No
   b. Comments:

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments: I found the sound scape most effective when interacting at close range of the projector - it was hard to tell the changes in sound initially as the sound-scape changes anyway

8. Did you find the interaction an aid in understanding how others might see the work, and the world, differently?
   a. Yes (Maybe) No
   b. Comments: I think it possibly needs a little bit extra information on each element of the exhibition - especially if experiencing on your own.

9. Were there any themes in the art that you felt were well expressed?
   a. Comments: It was interesting to see the different layers of information that were encoded within the images & the idea of different people being able to experience it differently from anybody is intriguing

10. Any other thoughts that you have on the exhibit will be helpful:

For a research exhibition it might be helpful to have a little more explanation as to the intention behind each piece - even if this is offered in a separate booklet.

This exhibit contains research done towards David Lyons' PhD. By answering the following questions, you will help further that research.

1. Is the colour blind test imagery familiar?
   a. Yes Maybe (No)
   b. Comments:

2. Did being familiar with the colour blind test give you insight into what messages, ideas or themes these prints might be communicating?
   a. Yes (Maybe) No N/A
   b. Comments:

3. Did the prints communicate different messages when viewed from different vantage points – from afar, from close up, from the side?
   a. (Yes) Maybe No
   b. Comments:

4. Did you interact with the computers and software?
   a. (Yes) (No)
   b. Comments:

5. Did you find the software an aid in understanding how others might see the work, and the world differently?
   a. Yes Maybe (No)
   b. Comments:

6. Did you interact with the projected piece?
   a. Yes No
   b. Comments:

7. Did you interact with its soundscape?
   a. (Yes) No
   b. Comments:

8. Did you find the interaction an aid in understanding how others might see the work, and the world differently?
   a. (Yes) Maybe No
   b. Comments:

9. Were there any themes in the art that you felt were well expressed?
   a. Comments: the feeling emotion that one astonished out of the viewer. direct interaction!

10. Any other thoughts that you have on the exhibit will be helpful: Colour, expression, atmosphere, detail all worked perfectly together

Brilliant show!

Double Blind Test Series Quesionaire

Double Blind Test Series Questionnaire

Double Blind Test Series was developed to further research in particular areas. Any feedback that you can provide will help the research and is greatly appreciated. If needed, please use the back of this sheet for further comments.

Please circle your choice: 1= poor, 5= excellent

1. Did you enjoy the work?
   1 2 3 4 (5) Comments:

2. Were you engaged by the work?
   1 2 3 4 (5) Comments:

3. Was the colour-blind test inspiration obvious?
   1 2 3 4 (5) Comments:

4. Were you able to see the embossments and Braille dots in some of the prints?
   1 2 3 4 (5) Comments:

5. Did the text in the prints work as visual texture?
   1 2 3 (4) 5 Comments:

6. Were you able to see portions of the transparent and translucent text printed on some of the prints?
   1 2 3 4 (5) Comments:

7. Did you like the titles?
   1 2 3 4 (5) Comments:

8. Which print did you think was the most effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments:

9. Which print did you think was the least effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments:

10. Would you recommend the exhibition to a friend?
    1 2 3 4 (5) Comments: aesthetically beautiful work with a rich + engaging body of research to support it... what more could you ask for?!

Please return to the Hannah Maclure Centre, University of Abertay or David Lyons (d.lyons@dundee.ac.uk)

Double Blind Test Series Questionnaire

Double Blind Test Series was developed to further research in particular areas. Any feedback that you can provide will help the research and is greatly appreciated. If needed, please use the back of this sheet for further comments.

Please circle your choice: 1= poor, 5= excellent

1. Did you enjoy the work?
   1 2 3 (4) 5 Comments: Yes very interesting

2. Were you engaged by the work?
   1 2 3 (4) 5 Comments:

3. Was the colour-blind test inspiration obvious?
   1 2 3 (4) 5 Comments:

4. Were you able to see the embossments and Braille dots in some of the prints?
   1 2 3 (4) 5 Comments:

5. Did the text in the prints work as visual texture?
   1 2 (3) 4 5 Comments:

6. Were you able to see portions of the transparent and translucent text printed on some of the prints?
   1 2 3 (4) 5 Comments:

7. Did you like the titles?
   1 2 3 4 5 Comments: Yes

8. Which print did you think was the most effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments:

9. Which print did you think was the least effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments:

10. Would you recommend the exhibition to a friend?
    1 2 3 (4) 5 Comments:

Please return to the Hannah Maclure Centre, University of Abertay or David Lyons (d.lyons@dundee.ac.uk)

Double Blind Test Series Questionnaire

Double Blind Test Series was developed to further research in particular areas. Any feedback that you can provide will help the research and is greatly appreciated. If needed, please use the back of this sheet for further comments.

Please circle your choice: 1= poor, 5= excellent

1. Did you enjoy the work?
   1 2 3 4 (5) Comments:

2. Were you engaged by the work?
   1 2 3 4 (5) Comments:

3. Was the colour-blind test inspiration obvious?
   1 2 3 4 (5) Comments:

4. Were you able to see the embossments and Braille dots in some of the prints?
   1 (2) 3 4 5 Comments: More down to my lack of visual field's

5. Did the text in the prints work as visual texture?
   1 2 3 (4) 5 Comments:

6. Were you able to see portions of the transparent and translucent text printed on some of the prints?
   1 2 3 4 (5) Comments:

7. Did you like the titles?
   1 2 3 4 (5) Comments:

8. Which print did you think was the most effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments: The experience of interacting with the print mimicks the experience of blindness

9. Which print did you think was the least effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments: But I'm not colour blind

10. Would you recommend the exhibition to a friend?
    1 2 3 4 (5) Comments: Yes the visual impact and intellectual variations on a theme are interesting and intriguing.

Please return to the Hannah Maclure Centre, University of Abertay or David Lyons (d.lyons@dundee.ac.uk)

Double Blind Test Series Questionnaire

Double Blind Test Series was developed to further research in particular areas. Any feedback that you can provide will help the research and is greatly appreciated. If needed, please use the back of this sheet for further comments.

Please circle your choice: 1= poor, 5= excellent

1. Did you enjoy the work?
   1 2 3 4 (5) Comments: The capacity for 'learning' / communicate

2. Were you engaged by the work?
   1 2 3 4 (5) Comments: yes, creative and other uses.

3. Was the colour-blind test inspiration obvious?
   1 2 3 (4) 5 Comments: yes I thought provoking

4. Were you able to see the embossments and Braille dots in some of the prints?
   1 2 3 4 (5) Comments: yes.

5. Did the text in the prints work as visual texture?
   1 2 3 (4) 5 Comments: yes

6. Were you able to see portions of the transparent and translucent text printed on some of the prints?
   1 2 3 4 5 Comments:

7. Did you like the titles?
   1 2 3 4 (5) Comments: hard them, made you think out of the box.

8. Which print did you think was the most effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments:

9. Which print did you think was the least effective or interesting? (Please circle the title or describe the print as best you can.)
   •Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
   Comments:

10. Would you recommend the exhibition to a friend?
    1 2 3 4 (5) Comments: yes - to encourage thinking in the area of communication + learning

Please return to the Hannah Maclure Centre, University of Abertay or David Lyons (d.lyons@dundee.ac.uk)

Double Blind Test Series Questionnaire

Double Blind Test Series was developed to further research in particular areas. Any feedback that you can provide will help the research and is greatly appreciated. If needed, please use the back of this sheet for further comments.

Please circle your choice: 1= poor, 5= excellent

1. Did you enjoy the work?
1 2 3 4 (5) Comments: Very accessible to general public — but also inspires deep questions about art / perception / "seeing"

2. Were you engaged by the work?
1 2 3 4 (5) Comments:

3. Was the colour-blind test inspiration obvious?
1 2 3 4 (5) Comments: yes but I am a Reader in Psychology!

4. Were you able to see the embossments and Braille dots in some of the prints?
1 2 3 4 (5) Comments: yes & I enjoyed the aspect of colour only response from me versus texture only response as the white-on-white

5. Did the text in the prints work as visual texture?
1 2 3 4 (5) Comments: Yes plus the aspect of "flipping" between surface + deep texture

6. Were you able to see portions of the transparent and translucent text printed on some of the prints?
1 2 3 4 5 Comments: Yes & when it caught me by surprise - good "walk" from picture to picture

7. Did you like the titles?
1 2 3 4 (5) Comments: But baffling! I couldn't figure it but responded as bursts of lovely words to say aloud!

8. Which print did you think was the most effective or interesting? (Please circle the title or describe the print as best you can.)
•Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
Comments:
impossible to compare since every one should be assessed on Environment & my response to each is fundamentally different

9. Which print did you think was the least effective or interesting? (Please circle the title or describe the print as best you can.)
•Oddity is not the pattern, •Working Spontaneously Would Be Rash •Beyond Mere More •Tongue Star and Gold Tooth •Buddha Accordion, By And By •Anonymous Play, Cannot Fatten Words •Concrete Imaging •Approaching Reasons Unknown •Day-Glo Precognition •Hanging Teeth Sizzle.
Comments:

10. Would you recommend the exhibition to a friend?
1 2 3 4 (5) Comments:
I would be happy to give further feedback on this
Siobhan MacAndrew s.macandrew@abertay.ac.uk

Please return to the Hannah Maclure Centre, University of Abertay or David Lyons (d.lyons@dundee.ac.uk)